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October 1856

SIX LECTURES
ON
THE PATHOLOGY OF STRABISMUS,
AND
ITS TREATMENT BY OPERATION.



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SIX LECTURES
ON
THE PATHOLOGY OF STRABISMUS,
AND
ITS TREATMENT BY OPERATION.

DELIVERED AT
The Westminster Hospital.

BY
C. HOLTHOUSE, F.R.C.S.E.,
ASSISTANT SURGEON TO THE HOSPITAL, AND LECTURER ON ANATOMY
IN ITS MEDICAL SCHOOL.



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TO

PETER MERE LATHAM, M.D.,

PHYSICIAN EXTRAORDINARY TO THE QUEEN, AND LATE PHYSICIAN TO

ST. BARTHOLOMEW'S HOSPITAL,

WHOSE WRITINGS AND HIGH CHARACTER

HAVE DONE SO MUCH TO EXTEND THE USEFULNESS OF THE MEDICAL

PROFESSION, AND TO ENHANCE ITS CLAIMS ON THE RESPECT

OF SOCIETY,

These Lectures

ARE DEDICATED

BY HIS FORMER PUPIL,

IN

GRATEFUL REMEMBRANCE OF THE VALUABLE INSTRUCTION

DERIVED FROM HIS TEACHING,

AND IN ACKNOWLEDGEMENT OF THE MANY KINDNESSES SINCE

EXPERIENCED AT HIS HANDS.

PREFACE.

THE following Lectures were delivered at the Westminster Hospital during the early part of the present year, under the circumstances detailed in the first Lecture. The reasons which induced the Author to deliver them to the pupils would seem to justify their being placed before the Profession at large, and their publication has accordingly been undertaken. Should the directions for the guidance of the Surgeon in his selection of cases for operation lead to more favourable results than have hitherto been attained, the object of their Author will be accomplished.

9, *New Burlington Street*,
May, 1854.

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LECTURE I.

ON THE ANATOMY AND PHYSIOLOGY OF THE MUSCLES OF THE EYEBALL.

GENTLEMEN,

IN the year 1840, an operation was proposed for the cure of strabismus, which consisted in the division of the internal rectus muscle ; and as it was both simple and easy of performance, unattended with danger, and usually successful in its results, most surgeons of that period undertook the operation, myself among the rest ; I besides assisted in its performance in a very large number of cases.

This afforded me the opportunity of making many observations and experiments on the actions of the orbital muscles, the pathology of strabismus, and the causes of failure which were observed to take place in several instances ; and I contemplated at that time placing the results of my experience before the Profession, but so many writers on the same subject were then in the field, that I laid aside my notes, and thought little more of the subject.

A case, however, which I met with in the out-

patient room of this Hospital, about the end of last summer, served to remind me of my omissions, and I determined without more delay to take up the subject afresh, and embody my observations in a short course of Lectures.

The case alluded to, was that of a young man who, as I have already remarked, presented himself at the out-patient room with an ulcer on the leg ; but what most struck me was the peculiarity of his appearance, resulting from one eye being apparently much larger than the other ; yet it was evident that this increase of size was only apparent, and was the consequence of a protrusion of the eye-ball from its socket.

Now such a protrusion may take place from a variety of causes ; such as tumours connected with the posterior part of the orbit which, as they enlarge, push the eye forward ; or collections of matter in the same situation ; or from the opposite cause,—a want of due pressure exerted on the anterior part of the eyeball by the eyelids, as occurs in facial paralysis, so that it projects somewhat more than the other.

None of these causes, however, were productive of the deformity in the present case ; it had resulted simply from the division of the internal rectus muscle for the cure of strabismus.

The young man told me, that the operation had been performed in one of the public hospitals in this metropolis, about eighteen months previously.

Now such a result as this could never have been intended, and the inference is, either that the operation was not properly performed, or, what is equally probable, the case was such a one as ought never to have been meddled with.

This, as well as other cases of a similar character, that have fallen under my notice, in which the operation has been of recent date, lead me to suspect that the principles which should guide us in the selection of our cases, is even now not clearly understood by the Profession.

To point out to you the description of cases that will be benefited by the operation, together with the proper mode of performing it, will be the principal object of these Lectures. This, however, will involve a previous consideration of the pathology of strabismus, and of the anatomy and physiology of the muscles of the eyeball; I shall devote the present Lecture, therefore, to the anatomical part of my subject.

I have so recently described these muscles in connexion with the course of anatomy which I am now delivering to you, that I shall at present merely redirect your attention to those points which are more immediately connected with the subject of strabismus, some of which, I have reason to believe, are not generally known to the Profession.

In the first place, then, you will recollect that the

four straight muscles arise immediately around the optic foramen ; being connected partly with the bone, and partly with the fibrous sheath of the optic nerve, and that they diverge from this point to their insertions into the sclerotic, a short distance behind the margin of the cornea.

The two obliqui muscles, on the contrary, proceed to their insertions from before backwards, and become connected with the sclerotic on the posterior hemisphere of the eyeball.

The external and internal recti, you will remember, are larger than the superior and inferior ; and of the two former, the external exceeds the internal in size, though the latter is broader at its insertion.

The breadth of the insertions of the tendons of these muscles, and their distance from the cornea, have an important bearing on the operation for the cure of strabismus, and require a further notice on the present occasion.

From measurements which I have made of these parts in twelve adult human eyes, the following is an average of the results obtained :—

The breadth of insertion of the

Inferior rectus is	4·571	lines.
Superior ditto	4·714	„
External ditto	5	„
Internal ditto	5·428	„

The distance of these tendons from the cornea also

varies slightly, the central portions being nearer to it than the margins, as seen below. Distance from the cornea of the central portions of the tendons of the

Inferior rectus is	} 2·714 lines.	
Superior ditto		
External ditto		
Internal ditto	2	„

Distance from the cornea of the margins of the tendons of the

	External Margin.	Internal Margin.
Inferior rectus	4·285	3·285
Superior ditto	4·285	3·571
	Superior Margin.	Inferior Margin.
External rectus	3·828	3·571
Internal ditto	3·428	3·428

These measurements were made with the compasses and not with a thread, so that the above figures indicate the relative, rather than the actual dimensions of the tendons of these muscles, and of their distances from the cornea. So broad is the insertion of the tendon of the internal rectus muscle, that it not unfrequently exceeds the diameter of the cornea,—a very important fact to recollect, when proceeding to operate for convergent strabismus.

The distance between the inner margin of the inferior rectus, and the lower margin of the internal was less, in the majority of the eyes examined, than that of the contiguous margins of the other recti ; and

such an arrangement seems well calculated to give to the cornea that slight downward and inward direction, which is perhaps the most frequent of the movements in which the eyes are engaged ; at any rate, this position of the cornea would be facilitated by such an arrangement.

From what I have just stated, you will understand that the tendons of these muscles are perfectly separate from each other ; and do not coalesce by their margins, as was formerly supposed, to constitute the so-called tunica albuginea ; but are inserted into the sclerotic in the manner described by Mr. Bowman—their extremities becoming imbedded in its substance.

The two obliqui are inserted as usually described, between the superior and external recti muscles, posterior to the vertical axis of the eyeball, and the inferior nearer to the optic nerve than the superior.

All these muscles, as well as the levator palpebræ, are connected together, and enclosed by a fascia (the ocular fascia) which invests likewise the eyeball as far forwards as the cornea, and as far backwards as the optic nerve.

This structure, which has been variously described, and under different names, as the membrane of Tenon, the tunica vaginalis oculi, the subconjunctival fascia, &c., and of which the best account is to be found in the last edition of the “Dublin Dissector,” by Profes-

sor Harrison, is very thin posteriorly, but becomes thick, strong, and dense, anteriorly, constituting the tunica albuginea of some authors.

By the reflexion of this membrane, if so it may be designated, around the tendons of the recti, and thence to the sclerotic, small spaces are left between that tunic and the insertions of those muscles ; which, by some anatomists have been mistaken for synovial bursæ occupying this situation.

The practical point in connexion with this structure, to which I am desirous of directing your attention, is, that three layers of this fascia intervene between the conjunctiva and the sclerotic : viz. the subconjunctival layer, the submuscular, and that which immediately invests the sclerotic ; all of which must be divided in the operation I shall hereafter speak of, for the cure of strabismus.

You will now be able more clearly to understand the actions of the orbital muscles.

The action of the recti muscles individually is obvious, each will direct the cornea towards the point indicated by its name. Not less so, is the action of two contiguous recti : the cornea will be directed in the diagonal of the two forces, supposing them to contract with equal power ; while the action of each in succession will give to the eye a movement of circumduction.

Can the four recti acting together retract the eye ?

I believe not ; however some ophthalmic surgeons maintain the contrary, and affirm that such a movement of retraction is very obvious during the performance of operations on this organ, as those for cataract. A movement of the whole globe backwards undoubtedly takes place under these circumstances ; but it is not one of retraction, but of depression ; and is produced by the contraction of the orbicularis. This is proved by the fact, that no such movement can be made to take place when this muscle is paralysed, as in facial paralysis ; while it can be effected when the recti are paralysed, provided the orbicularis remains unaffected.

I first ascertained this curious fact in the year 1841, while examining a patient suffering from paralysis of the third pair of nerves. The symptoms were ptosis, external strabismus, dilated pupil, and a total inability to move the eyeball from the position in which it was drawn by the external rectus. Raising the upper lid gently with my thumb, I told the patient to close her eye, and in her efforts to do so, the orbicularis visibly depressed the globe towards the bottom of the orbit, and at the same time moved the cornea somewhat inwards, so that it was made to occupy a situation midway between the external and internal canthi of the eyelids.

This demonstrates very beautifully the action of the orbicularis ; the lids are not approximated by a

perpendicular movement of each, but by an oblique ; the upper descending with an inclination inwards, while the lower ascends with a similar inclination. These movements, which are more marked in forcible closure of the eyelids, serve the obvious purpose of directing the tears, or any extraneous bodies that may enter the eye towards their natural outlet, the nose ; and they are explained by the muscle having its most fixed attachments at the inner canthus of the lids ; while its depressing effect upon the eyeball is explained by the straightening of the arched fibres of the eyelids, in consequence of the fixity of its two extremities.

The action of the obliqui muscles is now pretty well understood. They roll the eye round an imaginary axis, passing through the centre of the cornea to the posterior part of the sclerotic. This was pointed out long ago by Hunter ; more recently by Hücke and Dr. Jacob, of Dublin, and it has been proved to demonstration by my friend and late colleague Dr. George Johnson, whose experiments on this subject will be found in an excellent article in the "Encyclopædia of Anatomy and Physiology."

Other actions have, however, been ascribed to them, as that of moving the eye in the same direction as could be given to it by the joint contraction of two contiguous recti ; but as the necessity of this is not very obvious, Sir Charles Bell propounded a very in-

genious theory of their actions. He supposed them to be involuntary muscles, whose functions came into play when those of the recti were suspended ; and whose office was to roll the eye upwards and inwards during “sleep, faintness, and insensibility.”

Unfortunately for this theory, the cornea does *not* occupy this position during sleep, as I have incontestably proved by an examination of the eyes of nearly 200 individuals while sleeping. The upward and inward movement which is observed to take place in fainting and insensibility, is due to the action of the superior recti combined with the internal ; inasmuch as if the power of inverting the eye be lost by the division of the internal rectus, the diagonal movement of this organ upwards and inwards cannot take place, either voluntarily or involuntarily.

A paper embodying these facts and some others, which completely refute Sir Charles Bell’s views of the action of the obliqui, I some years ago transmitted to the Medical and Chirurgical Society for perusal ; but withdrew just previous to the time at which it would have been read.*

I have no hesitation, therefore, in affirming that these muscles possess no power of directing the cornea towards any point that can be given to it by the recti.

Can the obliqui cause protrusion of the eye ? In

* This paper is inserted at the end of this Lecture.

the normal condition of these muscles, and their antagonists the recti, I believe that neither protrusion nor retraction takes place. It is true I have no examples to offer, against the power of the obliqui to produce such a forward movement of the eyeball, I rather infer it from analogy with the recti, which I have proved have no power to produce retraction.

Circumstances undoubtedly may and do occur, in which either retraction or protrusion may take place ; viz. when the antagonism between these two sets of muscles is disturbed ; in their natural condition they are so nicely balanced, that neither protrusion or retraction to any extent ever occurs ; but if the power of either set of muscles is weakened or strengthened, then this balance is destroyed ; and retraction or protrusion is the consequence. This has an important bearing on the operation for strabismus, for, as we shall see by and by, the division of one of the recti, by weakening the retractive force, relatively increases that of the opposing one ; so that some degree of protrusion under these circumstances must always be looked for, and discrimination must be exercised in determining what cases are, and what are not, proper for the operation.

Having said thus much on the attachments and actions of the orbital muscles, I will, in my next Lecture, call your attention to the phenomena of strabismus.

AN INQUIRY INTO THE ACTIONS OF THE OBLIQUE MUSCLES OF THE ORBIT.*

THE observations about to be submitted to the Society, were suggested by witnessing the effects resulting from the operation for the cure of strabismus; and the object of the paper is to point out the true functions of the oblique muscles of the eyeball.

The means which have been employed hitherto for determining the action of these muscles are, first, an examination of their origins and insertions; secondly, artificial traction exerted on them in the dead body; thirdly, experiments made on living animals; and, fourthly, an observation of the phenomena consequent on disease of the orbital muscles, or of the nerves by which they are supplied; the progress of modern

* This contribution to the physiology of the muscles of the eyeball, was written in 1841, and intended as an introduction to another paper on the same subject; but after it was written I ascertained that the true actions of the oblique muscles, which were to have formed the subject of my second paper, had been pointed out long before by Hunter, while a very able paper on the same subject had been published at Dorpat in 1838 by Hücke, an abstract of which by Tourtual, appeared in Müller's Archiv. for 1840., pp. LII. to LXII. Under these circumstances I gave up all idea of writing the second paper, so that the present contribution is confessedly incomplete, and extends only to the pointing out of what are *not* the actions of the obliqui, and the refutation of Sir Charles Bell's views on the subject.

surgery has lately added a fifth, I allude to the division of one or more of them for the cure of strabismus.

In the present investigation, it is proposed to analyse certain phenomena resulting from this new operation. The effects which follow a successful division of the rectus internus for convergent squint, are, an alteration in the direction of the cornea, which has assumed a position intermediate between the external and internal canthi of the eyelids ; an inability in many cases to direct it inwards, inwards and upwards, and inwards and downwards ; and a greater or less protrusion of the eyeball. This last phenomenon I shall first proceed to investigate. What are the forces by which the human eye is retained in its orbit ? and what counterbalancing power is there to prevent the undue exercise of these forces ? The solution of this problem will afford us an explanation of the phenomenon in question. The principal retaining powers are, the optic nerve, the four recti muscles, the eyelids, the conjunctiva, and atmospheric pressure. To counterbalance these, we have the form and size of the orbit, the weight of the eye, and the action of the two oblique muscles. It is then by the united antagonism of these powers that the eye is retained “in situ ;” destroy any of them and the equilibrium is disturbed. Are the obliqui injured or divided ? the action of the recti is not sufficiently opposed, and the eye is retracted. On the

contrary, are any of the recti divided, as for the cure of strabismus ? the obliqui then exert an undue influence and protrusion of the globe is the consequence.

These assertions are fully borne out, not only by the results which are observed to ensue in the operation in question ; but also are confirmed by experiments on the eyes of brutes. Mr. Bransby Cooper divided the two oblique muscles in the eye of a rabbit ; the result was “ the permanent retraction of the globe within the orbit.”

I have repeated this experiment of Mr. Cooper, and can bear witness to the accuracy of his account.

Many eminent physiologists have denied that there is any antagonistic relation between the recti and obliqui ; and in support of this opinion, they refer to the obliquity with which the last named muscles pass to their insertions, and to their disproportion in number and strength. But surely this disproportion is no argument against their antagonism, or it would apply equally to the flexors and extensors of the fingers, and to the elevators and depressors of the lower jaw :—besides, in denying this relation between the two classes of muscles, they do not provide us with any equivalent for the want of the oblique muscles ; nor are they able to adduce a single example, in which a group of voluntary motor muscles has not also antagonists. They admit that the two obliqui can act together ; and it must be obvious

that their united action, if unopposed, would draw the eye forwards. By what power, then, would it be restored to the position in which it was previous to their contraction ?

If we were to allow that mere relaxation of the contracting muscle, or the elasticity of the coats of the eye, was sufficient, it would be contrary to what obtains in the other parts of the muscular apparatus of this organ. Thus, it is not sufficient that the levator palpebræ should relax in order to close the eye, the orbicularis palpebræ must also contract to effect this object ; and the contrary ; simple relaxation of the last named muscle, does not suffice to separate the lids ; for this purpose we have the levator, which opens them.

These facts are well illustrated by cases of paralysis of the seventh and third nerves. Analogical reasoning, then, as well as a consideration of the origin and courses of these muscles, and the evidence of direct experiments, are in favour of the recti and obliqui being antagonists. I have viewed them hitherto only as antagonists, and in order to account for the protrusion of the eyeball which follows division of one or more of the recti for the cure of strabismus.

But in speaking of them in this light, it is not meant to be asserted that the human eye can be retracted perceptibly, as we see quadrupeds draw in their eyes by an act of volition exerted upon the

recti, or made to protrude by a voluntary effort to contract the obliqui ; it is more probable, that the state of antagonism of these muscles is essential to the due performance of their individual actions, so that they not merely oppose, but by opposing, mutually aid each other. To use the language of the anatomist Cowper, “ They (the obliqui) not only pull the eye directly forwards, but they hold it from being retracted when any of the four straight muscles act, which otherwise would rather draw it inwards, than turn it either sideways, or upwards, or downwards. But these muscles, one of them descending inwardly from the uppermost, and the other ascending from the lowermost edge of the orbit to their insertions, in effect not unlike an axis, prevent its being retracted.”

Having then determined what must be the conjoint action of the two obliques, it remains to inquire into their individual actions and uses.

From the earliest period at which attention was directed to the subject, anatomists have attributed to these muscles a power of revolving the eyeball in certain directions, in which it can be moved by the joint contraction of two contiguous recti ; yet it is a remarkable fact, that even in the present day they are not agreed on what is this direction. Such a want of accordance, while it proves the obscurity of the subject under investigation, at the same time tends to suggest a doubt whether the movement of the

eyeball, in any of these directions, is due to the above-named muscles. The following facts to which I am about to direct the attention of the Society, would seem to show that they possess no power of doing so.

We have seen that after division of the internal rectus, there is not only a greater fulness of the eye, but that the cornea, which is now equidistant between the two canthi, cannot in many cases be rotated inwards, inwards and upwards, or inwards and downwards. Whence arises this inability, seeing that only one rectus is divided, and that the two obliqui remain intact ? Why do not these last named muscles impress upon the globe the revolving motions which are ascribed to them ? If the office of the inferior oblique is to roll the eye upwards and inwards, according to Hildebrant, Sir Charles Bell, Müller, and others, then the superior oblique, being its antagonist, will roll it downwards and outwards ; but after division of the internal rectus the pupil cannot be directed upwards and inwards. Again, if the inferior oblique turns it upwards and outwards, according to Mayo, Knox, &c., then the superior should turn it downwards and inwards ; but after division of the internal rectus the eye can no longer be turned in this direction.

In many cases these direct and diagonal movements of the eye inwards, are not wholly destroyed by the operation ; and some persons have therefore attributed them to the action of the oblique muscles ;

but in answer to this, it must be observed, that if the obliqui were able to effect these movements in one case, they should in all, which is certainly not the fact. This consequence, too, is generally immediately rectified by the division of a few of the inner fibres of the superior or the inferior rectus : now this could not happen were it produced by either of the obliqui. During the prevalence of that erroneous notion, which regarded a perfect loss of power to invert the eye as the only test of the completeness of the operation for the cure of strabismus, a young man presented himself to a friend of the writer, to be operated on for a convergent squint of the left eye. The internal rectus was easily and completely divided ; but still the squint was not removed. The section of the conjunctiva was then continued upwards and downwards, till the whole of the sclerotic intervening between the inferior and superior recti was laid bare. On the patient looking straight forward his left eye still converged, although not to the extent that it did before the operation ; and he could still turn the cornea inwards towards the nose, but in a less degree than before. This not appearing satisfactory either to the operator or to the patient, the inner half of the inferior rectus was divided just where it was inserted tendinous into the sclerotic. The eye now protruded considerably, the cornea was drawn slightly upwards and outwards, and all power of turning it

inwards, upwards and inwards, or downwards and inwards, was annihilated.

If any further proof were wanting that the slight convergence which sometimes persists after the division of the internal rectus is not owing to the action of either or both of the obliqui combined, it is to be found in those cases in which the superior oblique has been cut through in order to remedy this. Such a case has been reported by Mr. Lucas, in his work on Strabismus, at page 84 of which we find the following :—“ Having read in the ‘ Medical Gazette ’ that the best results followed the division of the superior oblique muscle, I was induced to do so in one instance, without the slightest perceptible advantage being derived by its section.” He informs us, also, that Mr. Calder of the Life Guards, performed the same operation, but with no advantage.

Now had the superior oblique produced the squint, its division would have rectified it ; had the inferior caused it, the section of its antagonist would have increased it ;—were the convergence produced by their joint contraction, either it would have been increased, or altered in direction ; but no such result followed.

When, however, anatomists tell us that the superior oblique directs the pupil downwards and outwards, and the inferior oblique upwards and inwards ; and then speak of the conjoint action of these muscles

rolling the eye inwards ; it is difficult to understand how this can happen. A muscle that moves a body in one direction, cannot possibly assist another that moves it in a contrary ; they must necessarily be antagonists, contracting with equal force the body acted on, would remain at rest in the diagonal of the two forces ; when, therefore, they speak of the cornea being directed upwards by the joint contraction of the two obliqui, it must be by the stronger action of the inferior overcoming that of the superior.

To apply this reasoning to the case under consideration : were it by the strong contraction of the inferior oblique that the squint persisted after division of the internal rectus, it is evident that division of the superior oblique would have increased the deformity. But if now we suppose, with Albinus, Cowper, Haller, and others, that the superior oblique directs the pupil downwards and inwards, and the inferior upwards and inwards, then it is clear their combined action would turn it directly inwards ; division of the superior oblique in this case would have changed a squint directly inwards for one upwards and inwards ; but what happened ?—did any perceptible change take place ? None whatever ; we only learn that no advantage resulted from the operation.

The report of these operations by Mr. Lucas, not only bears out the views advanced in this paper, but

is remarkable as showing the little faith which anatomists place in their own accounts of the action of these muscles. Thus, Mr. Lucas having informed us that the action of the inferior oblique is to direct the eye upwards and inwards, and that of the superior oblique downwards and slightly outwards, does not hesitate to divide this last-named muscle, in order to rectify a convergent squint. Having now disposed of the question, as to whether the oblique muscles possess any voluntary power of inverting the eye, let us inquire whether they are able to evert it. This is a problem not so easy of solution as the former.

Cases in which the external straight muscle has been divided for the cure of divergent squint are comparatively rare ; and where the operation has been performed, its effects are seldom so decided as those which follow the section of the internal rectus.

It has not fallen to the lot of the writer to meet with a single instance in which the divergence was completely removed by the division of the external rectus of one eye only ; that is to say, if one eye were directed upon an object placed directly in front of it, the other always deviated in a greater or less degree outwards ; so that the axes of the two eyes could never be brought into a perfect state of parallelism in this direction.

The evidence, then, to be derived from a section of the external rectus muscle is less complete than that

which results from a division of its antagonist ; for however slight may be the power of everting the eye after division of the abductor muscle, we cannot say that the eversion is not owing to the joint contraction of the two obliques. And although in all the cases examined, the upward and outward, and downward and outward movements of the globe existed only in the same degree as the directly outward, yet we cannot positively assert that the rotation of the eye, in either of these directions, is not due to the individual action of the inferior and the superior oblique muscles. It must not be forgotten, also, that these are the directions which have been ascribed to their contraction by Mayo, and other celebrated anatomists. Much, however, as the want of positive evidence on this point is to be regretted, the probability that the obliqui have no more power to evert the eye than they have to invert it, is so strong as to be almost tantamount to direct proof. Analogy is certainly in favour of this view ; for if it be admitted that some degree of inversion can be produced by the contraction of the inner fibres of the superior and the inferior recti, we can hardly deny to the external portions of these muscles a similar power to evert the eye.

Another fact more strongly corroborative of this opinion is, that the diagonal movements upwards and outwards, and downwards and outwards, are always

in an exact ratio with the directly outwards ; so that the further the eye is able to be everted, the more complete are the diagonal movements, and the contrary. Now, if these diagonal movements of the eyeball were produced by the obliqui, should they not take place always to an equal extent ?

I lately examined a patient who was affected with incomplete paralysis of the motor oculi nerve of the right eye, and perhaps of the fourth and sixth, and the following are some of the phenomena as copied from my note-book : “ He can turn the eye directly inwards, and directly outwards, to about an equal extent, but not to so great an extent as the other eye. The movements upwards and downwards are also equal, but very slight. The upward and outward, and the downward and outward motions are as little decided as the directly upward and directly downward ; and in endeavouring to produce them the eye is drawn outwards, with scarcely a perceptible inclination in the upward or downward direction.” The inference then to be drawn from these facts is, that it is highly probable, although not amounting to absolute proof, that the oblique muscles have no voluntary power of everting the eye, or of giving to it any modification of outward movement ; but that these motions, as well as the corresponding ones inwards, are effected solely by the recti.

Such was the conclusion arrived at by Sir Charles

Bell. This celebrated physiologist having satisfied himself that the recti alone were fully equal to rotate the eye in all directions, very justly inferred that the office of the obliqui was not to assist them in these rotatory movements, "but that they must have some other appropriate office." The superior oblique, he informs us, turns the pupil outwards and downwards, and the inferior upwards and inwards ; but whereas the recti are the voluntary agents in effecting these movements, he assumed that the obliqui were involuntary. The orbital muscles, he observes, "are to be distinguished into two natural classes ; in sleep, faintness, and insensibility, the eyeball is given up to the one, and in wakefulness, and the full exercise of the organ, it is given up to the influence of the other class of muscles." Again, "when the eye is at rest, as in sleep, or even when the eyelids are shut, the voluntary muscles resign their office, and the involuntary muscles draw the pupil under the eyelid."

To get over the difficulty of both obliqui contributing to the upward and inward motion of the eye, he supposes that "the influence of the fourth nerve is, on certain occasions, to cause a relaxation of the muscle to which it goes, the eyeball must then," he says, "be rolled upwards." He supports his assumption of the involuntary action of the obliqui, by several experiments which he performed on animals,

and by an appeal to pathological phenomena. Having divided the superior rectus of a rabbit, on irritating the globe, the eye was turned upward. "So," observes our author, "though the voluntary motion was lost by the division of the rectus, the involuntary remained by the influence of the obliquus."

In the presence of Drs. Black and Twining, and Mr. Davies, I repeated this experiment, but obtained a different result. Neither before, nor after the division of the superior rectus, were we able to make the animal roll its eye upwards. The most obvious movements that take place on irritating the globe, are a winking of the eyelids, a protrusion of the brow, and a slight retraction of the whole eye ; but no rolling of it upwards ; it is probable, therefore, that Sir Charles Bell mistook the partial descent of the upper lid, which is extremely mobile and difficult to be fixed, for the ascent of the eyeball.

In another experiment Sir Charles Bell divided the facial nerve of a dog, "and yet the eye did not cease to turn up when he was threatened, and when he winked with the eyelids of the other eye."

"Nearly the same thing was observed in a girl, whose eyelids were attached to the surrounding skin owing to a burn, for the forepart of the eyeball being completely uncovered, when she would have winked, instead of the eyelids descending, the eyeballs were turned up."

The following facts, to which I am anxious to direct the attention of the Society, do not bear out Sir Charles Bell's views of the actions of these muscles.

Six individuals who, in consequence of having been operated on for strabismus, had entirely lost the power of voluntarily rolling the eye upwards and inwards during the waking state, were examined while sleeping, and this was what was observed : In four the cornea was directed straight forwards, having no inclination either upwards or downwards, or laterally. In one, both were directed very slightly downwards, yet occupied a position midway between the external and internal canthi of the eyelids. The other patient examined had the cornea of the eye operated on, turned upwards and outwards, whilst its fellow was turned upwards and inwards. This last patient was examined twice subsequently, and both corneæ then were placed centrally with respect to the eyelids. Not being sure whether this phenomenon, so contrary to the universally taught doctrine on the subject, might be peculiar to the eyes of squinters, it became imperative to examine the position of the healthy eye in sleep. Observations were accordingly made on a large number of hospital patients while asleep, and the following is the result : The majority had the eyes directed straight forwards, the cornea occupying a position midway, between the external and internal canthi, and inclined neither upwards nor down-

wards. In a few, one eye had a slightly downward and outward direction, while the position of its fellow could not be ascertained from the head being buried in the pillow. Fewer still had the eyes turned directly upwards, and in these it was doubtful whether the position was not taken during the separation of the eyelids; and none had them placed upwards and inwards. Through the kindness and with the assistance of Mr. Dyne, of Bolton House Academy, Turnham Green, I examined the eyes of between thirty and forty of his pupils while sleeping, and the result of this examination was the same as that of the hospital patients. In no case was the cornea directed upwards and inwards. In one it was turned slightly but directly upwards; in one downwards and inwards; in five slightly outwards, and perhaps in an equal degree upwards; and in all the others directly forwards, and neither downwards, upwards, nor laterally. Nearly all the boys were lying on their sides, one cheek resting on the pillow. Two or three were on their backs, and among this number was the single case in which the eyes were turned directly upwards. In all the above-mentioned cases the eyelids were closed, but in two fever patients in the hospital, they were partially open, and nothing but the white sclerotic was visible; on disturbing these patients, the eyeball was seen to descend, while the lids at the same instant became more widely separated. The

fact of the eyes being turned upwards during sleep, if the eyelids are *not closed*, is no evidence that this is their position *when closed*, although it is probable that the error we are controverting originated in an observation of these abnormal cases. Neither does it follow that this upward position of the eye is due to the oblique muscles : it is most probably a reflex action, and intended for the protection of the transparent part of the eye.

It is thus we would explain the turning up of the eyeball in the examples brought forward by Sir Charles Bell ; the eyelids being paralyzed in one case, and adherent to the surrounding skin in another.

This explanation is, perhaps, applicable to the rolling up of the eye which is observed in hysteria and in syncope ; and accounts for the same movement in the eye of a healthy individual, whose upper lid is temporarily prevented from descending by fixing it against the orbit. The probability that these movements are not due to the oblique muscles is strengthened by the following experiments.

A girl whose inner rectus had been divided, and who, in consequence, had lost all power of inverting the eye, or of giving to it any modification of inward motion, was prevented from closing her lids by pressing the upper one against the margin of the orbit. On desiring her to shut her eyes, the one whose lid was forcibly held up, was always rolled downwards

and outwards ; while the other eye, which had not undergone any operation, as regularly rolled downwards and inwards, when its lid was treated in the same manner.

A man also, whose external rectus had been cut through, rolled the eye upwards and as much outwards as he was able to do ; and the other eye upward and outward in about an equal degree.

In the patient with paralysis of the motor nerves of the orbit, whose case has been before alluded to, both eyes roll *directly upwards* when this experiment is made ; but the extent to which the paralyzed eye is elevated is precisely that to which it can be raised voluntarily when the lid is untouched.

We possess no evidence then in the examples adduced by Bell, that the obliqui are involuntary muscles : whilst the position of the cornea during sleep, at once undermines the theory we have been examining ; for the eye being directed straight forwards argues a complete state of balancing, or mutual antagonism of all the orbital muscles. Were the obliqui indeed involuntary agents to which the eye is given up in “sleep, faintness, and insensibility,” then, according to Sir Charles Bell’s explanation of their action, the eye ought to be turned upwards and inwards in sleep.

A review then of all the facts advanced in this paper, leads us to the conclusion that the office of

the oblique muscles in the human subject, is not to rotate the eye, either voluntarily or involuntarily, in any of the directions that can be given to it by the recti. This conclusion has been arrived at, not by making tractions on the muscles in the dead body, but by an analysis of certain physiological and pathological phenomena met with in the living ; and it is satisfactory to the writer to observe how, by a different mode of procedure, both Mr. Bransby Cooper and Mr. Duffin, have arrived at the same negative result.

The last named gentleman, divided the internal rectus muscle of a dog, and the pupil was directed permanently outwards, without the power of disengaging it from this situation. On dividing the external rectus of the same eye, a week afterwards, the pupil still continued everted.

In another experiment the external rectus only was divided, and the pupil became permanently turned inwards, but not quite in so great a degree as in the first experiment, it was turned outwards. Nor did the animal in this instance apparently possess any power to dislodge it from its unnatural situation.

“The inference to be deduced from the foregoing facts,” observes Mr. Duffin, “is that the oblique muscles take very little part in the lateral movements of the eyes.” But what happened when all the straight muscles of a dog were divided ? Let Mr. Duffin him-

self tell us : “ The pupil remained fixed in the visual axis of the orbit. When irritated, the eyeball was retracted, and the membrana nictatans was suddenly spread over the forepart of the eye at the same moment, so that it was quite impossible to decide what influence the oblique muscles exerted, or whether they produced any special movement at all. It was clear, however, that they neither drew the eye towards *the outer nor the inner angle* of the orbit. In juxtaposition with this last cited experiment of Mr. Duffin, let us place that of Mr. Bransby Cooper ; in which the two oblique muscles of a rabbit were divided : the result was, observes Mr. Cooper, “ The permanent retraction of the globe within the orbit, its depression on the floor of that cavity, the contraction of the pupil, without, however, *any lateral direction.*”

LECTURE II.

ON THE PHENOMENA OF STRABISMUS.

GENTLEMEN,

STRABISMUS is a deformity, which consists in a mal-direction of one or both eyes, or a want of power to move them together harmoniously, so that their axes shall always be directed at the same time to the same point. It is sometimes met with as a mere temporary affection, dependent on functional disorder in some part of the system, and therefore requiring for its removal only general remedies ; but the majority of cases that one meets with are of a permanent character, for the cure of which no such remedies would be of any avail. It is to the phenomena of permanent strabismus that I shall now direct your attention.

These phenomena differ somewhat according to the variety, for there are several varieties, as I shall presently show ; by far the most frequent of these is the *single convergent strabismus*.

If an individual thus affected looks at an object directly in front of him, but placed at some little

distance, as for example, a picture at the end of the room—the squinting eye, instead of being directed towards the object, is turned inwards, as if looking at the nose ; while the sound eye only is directed to the picture ; hence the optic axes do not converge to the same point, consequently, objects are seen with but one eye at a time. If instead of looking at an object placed in front of him, he be directed to look at one on either side, the same want of parallelism in the two eyes is observed as was apparent in the former case, they move together, but not in harmony with each other. Either the squinting eye is too much inverted in the one case, or too little everted in the other, the effect being the same, viz., that only one is made to bear upon the object gazed at, while the other or the squinting eye disregards it altogether. If we now desire the patient to close the sound eye, the other will be seen to move from its position in the inner canthus to the centre of the orbit, and can be directed freely by the patient towards any object he wishes, though generally to a less extent outwards than in other directions, or than can be done by the opposite or sound eye. On re-opening the latter, the squinting one instantly returns to its former position in the inner canthus. If both eyes are closed, and the lid of each then gently raised by the thumbs, the squinting eye will invariably be found more or less buried in the inner canthus.

In some cases of single convergent strabismus, the inversion is not constantly present in the same eye, but shifts to the opposite one, where it will sometimes remain for a considerable period. Under these circumstances it is not always possible to determine which is the eye affected, until we compare the vision of the two ; when it will be found that the really squinting eye is defective in visual power as compared with the other. Mr. Walton points out another mode of diagnosis. He directs the patient to close each eye alternately, while he is desired to look at an object a short distance in front of him with the eye which remains open. Now if this be the sound one, it will continue to preserve its position in the centre of the orbit when the lid of the closed eye is raised, but if it immediately turn inwards, it is certainly the one affected. The same experiment should be repeated with the other eye.

The rationale of this test is apparent : it depends on the fact I have just pointed out, viz., the defective vision of the squinting eye.

A little boy, ten years of age, was brought to the Dispensary a few days ago, for a sty on the outer part of the left upper lid, the eye on the same side was also considerably inverted. At first sight I concluded that this was a case of single convergent strabismus of the left eye ; but on placing a book before it, I found its vision quite perfect ; while on placing

it opposite the other or straight eye, he could with difficulty decipher the letters. This fact at once assured me that the latter was the really strabismic organ, and that the inversion of the opposite one was only temporary, occasioned probably by the existence of the inflammatory swelling of the eyelid.

In the course of a few days the styne had disappeared, and, as I anticipated, the squint had disappeared with it, and had been transferred to the opposite eye. When he is looking about him it continually shifts from one eye to the other, but when he is directed to look steadily at an object, it is the left eye only which regards it, and the right becomes more strongly inverted.

When both eyes are closed alternately, the closed one always retreats to the inner angle, and has that position when its lid is raised, but the left or good eye immediately rights itself, and regards the object held before it, while the right becomes inverted. The contrary happens when the other eye is thus tested.

Notwithstanding the want of consent which exists between the eyes of those affected with the deformity we are speaking of, there are few who do not possess some degree of control over their movements, provided their attention be specially directed to this object ; but what is curious, is the difficulty which the squinter experiences of directing volition simultaneously to the rectification of the deformity and

the perception of objects. For instance, many squinters can by an effort of the will and by concentrating their attention to the maintenance of the parallelism of the eyes, succeed in preventing inversion so long as the head is kept steady, and the eyes directed as if at an object at some distance in front. But if their attention be diverted from this effort of rectification to one of perception or scrutiny, such as reading print placed at the extreme limit of distinct vision, the parallelism is at once destroyed, and the inversion of the squinting eye increases in proportion to the efforts made to perceive distinctly the object gazed at. The parallelism of the eyes is invariably destroyed on looking sideways, and no effort of volition appears capable of preventing this ; hence it is, that in these movements, the squint is always most apparent.

There is a subvariety of this deformity that I must here allude to, which is called *Lusctitas*, and is distinguished from the former by the greater immobility of the eyeball.

The patient in these cases is unable to move the eye from the inner angle, whether the sound one be open or closed, so that the cornea remains permanently in its unnatural position.

Although, as I have frequently remarked, single convergent strabismus is the variety most frequently met with, there are certain other forms of less fre-

quent occurrence, which call for some notice, and the next of which I shall speak is *Divergent strabismus*, which is the reverse of that we have just described, the affected eye being everted instead of inverted ; the degree of eversion, however, is seldom so great as the inversion in the former class of cases.

The phenomena presented are analogous to, though of course different from, what are observed in the convergent variety ; there is the same want of harmony in the movements of the two eyes, and in looking at an object placed in front they never converge to the same point, the sound eye only being directed to it, while the squinting one is more or less everted ; this is equally the case, whether the object regarded be placed at a short or a long distance from the face, and under no circumstances whatever, can the two eyes be made to converge simultaneously.

As regards their lateral movements, the phenomena are, *mutatis mutandis*, precisely analogous to those which are noticed in the convergent variety.

Lusitas with eversion is as frequently, and perhaps more frequently met with, than with inversion, and examples of both these forms, I shall by and by bring under your notice.

Double convergent strabismus, as implied by the name, affects both eyes ; and according to some writers, is of extremely rare occurrence, while others, on the contrary, consider the majority of cases to be of this description ; what one surgeon would regard

as a case of single, another would affirm to be double strabismus.

Mr. Walton, in his recent work on Ophthalmic Surgery, declares that he has seen but few cases of double strabismus, and that the apparent participation of both eyes in the deformity, is often merely a deceptive appearance, dependent on the association which naturally exists between their movements and the amount of volition required for the play of the muscles of the deformed eye. I will quote Mr. Walton's own example, in illustration of his meaning. "The right eye squints, to look to the right with that eye a much greater degree of volition is needed ; and more muscular power called into action than if it were straight, and that extra exercise of power is, by the associated movements of the eye, unavoidably transferred to the associate muscles of the other eye, the left ; and especially to its internal rectus, over-matching the antagonizing muscles, and turning it inwards."

Mr. Lucas, on the contrary, observes that "When both eyes are affected they are never turned in at the same time, so as to hide portions of both corneæ, though when one cornea is more than half hidden, the other has generally a slight inclination inwards." "Persons so affected" he says, "may lead an observer to believe only one eye is squinting, and he has met with patients, who for several hours would use but one eye in viewing an object."

Mr. Dalrymple observes, "Occasionally it happens that the power of the external straight muscles appears to be less than their antagonists ; and when both eyes are in repose, they are, instead of being parallel, inverted towards the inner canthus, constituting double convergent strabismus."

That there is an essential difference between the extremes of each variety, there can be no doubt, though it is not easy in all the intermediate cases to draw an exact line of demarcation between them ; the single appearing gradually to merge in the double form of strabismus.

This is probably owing to the sound eye participating more or less in the inversion of the distorted one, so that, when they are at rest, both appear to be inverted ; although when engaged in vision the sound one alone is used, and seems to be uninfluenced by the condition of the other. Here for instance is a case which, according to Mr. Walton, would be one of single convergent strabismus, while according to Mr. Dalrymple, it would be an example of the double variety.

Mrs. S., aged 28, of a healthy appearance, has convergent strabismus of the left eye, the pupil of which is more dilated than the other. When quite quiet and unobserved both eyes converge considerably, and to about an equal extent, whenever in fact the patient is not engaged in using them. On

being directed to look straightforwards at a pen held two or three yards in front of her, the right eye is straight, and is that with which she regards it, while the left is inverted.

On looking sideways to her left side, the right or sound eye converges too much, and the left diverges too little, so that they are not parallel, and she appears to squint with the right eye. On moving the pen to the opposite side, the right eye follows it, and sees it clearly, but the left becomes buried in the inner canthus. The movements of both eyes separately, or when one is closed, are quite perfect, and they can both be fully everted, so as to leave no part of the white of the eye visible between the cornea and the outer canthus. On closing each eye alternately, while the other is open and directed to an object a few feet in front of it, the right eye remains directed on the object when the lid of the other is raised, but the left becomes inverted under the like circumstances ; whichever eye be open, however, the closed one is always inverted.

Vision.—Right eye good; left imperfect ; objects appear to the latter misty and indistinct. She can see the window-frames, and persons about her, but cannot distinguish them ; can tell the number of fingers held up, and can read very large type, as “The Times,” on the top of the newspaper, but no type less than this.

History.—In this case the affection came on with-

out any obvious cause, two years ago, when the woman was pregnant with her last child ; she first observed that the sight of the eye was imperfect as she walked along the streets. She has never had double vision ; her neighbours first made her acquainted with “ the cast ” in her eye, and it has increased within the last few months.

Double convergent strabismus, according to the meaning which I attach to the term, affects both eyes *simultaneously*, and *not alternately*, as in certain cases of single strabismus ; so that they are habitually inverted whether engaged in vision or otherwise. Individuals thus affected make use of both eyes at a time in viewing objects whether near or distant, although they are necessarily very imperfectly seen. In the lateral movements of the eyes the same want of parallelism is observed as in single strabismus, though not to the same degree ; hence the deformity occasioned by double strabismus is not so great as that produced by a well marked example of the single variety ; this is particularly observable when vision is directed to an object in front of the individual, for the inversion of both eyes being equal is symmetrical, and therefore less unsightly than the contrast occasioned by one eye being inverted while the other is straight.

There is a patient now in Matthew Ward for stricture who has double strabismus. I will read you the

notes I took of his case:—"Both eyes converge unnaturally and to an equal extent: on placing myself in front of him, at the foot of the bed, he regards me with both eyes, neither being more inverted than the other. On directing him to look at an object on the opposite side of the ward, both eyes still remain equally convergent, and not one only, while its fellow is straight, as in single strabismus; so that whether he regards near or distant objects, both eyes converge alike, though the degree of convergence varies slightly, according to the distance. In the lateral movements of the eyes the squint becomes more apparent, from one being too much inverted and the other too little everted. Each of them, however, can be everted to nearly the natural extent. On closing them alternately, while he regards an object placed three feet in front of him, the closed eye is always found much inverted on rising its lid, while the previously open eye continues to regard the object.

"*Vision* is indistinct in both eyes, so that he cannot read the English type with either, though he sees best at about the ordinary focal distance of the healthy eye,—say ten inches. He is not aware of there being any difference in the vision of the two eyes; with each of which he sees equally well, or rather badly, all objects appearing misty and indistinct. A convex lens improves the sight, and he always makes use of spectacles of a high power

when employing his eyes in reading. He never sees double, under any circumstances, though his attention has been frequently called to this phenomenon.

“*History*.—He had his eyes ‘turned in,’ he believes, from infancy; while with his regiment in India he suffered severely from ophthalmia in both eyes, for which caustic was freely applied to the lids, but the strabismus underwent no increase from this attack.”

There are some kinds of squint of which it is difficult to say whether they should be placed among the examples of single or double strabismus, inasmuch as they partake of the characters of both, though not strictly belonging to either. They are the cases to which the term “Alternating” has been applied, and are peculiar, inasmuch as the vision of both eyes is unimpaired; and it is this which seems to regulate their movements. In viewing near objects both eyes are employed, so that, in this respect the alternating resembles double strabismus; while in regarding those at a distance the axis of only one eye is pointed towards them, as we have seen to be the case in single strabismus. There is this material difference, however, between them: in the single, the sight of the squinting eye is generally so imperfect that it is made no use of at all, and the good eye alone is used, whether in surveying near or distant objects; whereas in the alternating variety, both eyes being equally good, they are, as we have just

observed, used together, when viewing near objects, but *singly* and *indifferently* when regarding those that are more distant.

It is this alternate use of either one eye or the other that has given rise to the term "Alternating Squint," of which the following case is a good example:—

Mr. W., aged 21, has squinted from two years of age, and is not aware of any cause to which the deformity can be attributed, except it be hereditary tendency, to which he ascribes it; several of his relatives on his mother's side being, he says, similarly affected, and some of them in a higher degree than himself. It has existed in the family for several generations.

Phenomena.—Both eyes more convergent than natural, but equally prominent; pupils also alike. On regarding objects in front of him, while unobserved, one eye is always inverted, though not always the same eye, as he uses both indifferently, the vision of each being perfect; but if conscious that he is observed he can prevent the inversion of either eye singly, and maintain them both very nearly parallel, that is to say, the convergence is so slight as to be almost unobservable, and affects the two eyes equally.

On looking sideways one eye is too much inverted, and the other is too little everted. Notwithstanding this want of parallelism, he positively de-

clares that he sees an object, such as the finger held to the side of him, with both eyes at a time ; and sees it *single*, and this is the case whether the object be held to his right or left side. He never sees double under any circumstances whatever. The power of everting both eyes is somewhat imperfect, he being unable to approximate the cornea nearer than two lines of the outer canthus.

This is an extremely interesting case, inasmuch as it throws light on certain phenomena connected with binocular vision.

I presume most of you are aware that, as a general rule, for single vision with both eyes it is necessary that the image of an object gazed at should fall on identical or corresponding parts of the two retinae, and if this condition is not fulfilled double vision will result. Hence, certain physiologists have contended that the identity of these parts of the two retinae is an inherent property of that membrane ; while others, on the contrary, affirm that objects are seen single, not by any inherent property residing in it, but simply from certain parts of the two retinae being *accustomed* to act together ; and that under certain circumstances objects will be seen single, though their images are not depicted on such corresponding parts.

Now the case in question is decisive evidence of the correctness of the latter hypothesis, as the indi-

vidual never sees double, though it must be obvious, from the want of parallelism in the two eyes, that images must occupy *non-identical* points of the two retinae.

I have met with a case of double convergent strabismus in the practice of a medical friend, in which the sight of both eyes was good, but of unequal focal power; so that the patient was in the habit of employing one eye when he regarded near objects, and the other in surveying those more distant.

I find a similar case recorded by Monsieur Berard.

I have spoken hitherto of the more frequent and well recognised forms of squinting, but one meets occasionally with some more rare examples, in which the cornea is neither inverted nor everted, but directed upwards or downwards, and it is by no means unusual both for convergent and divergent strabismus, to be combined with a slight upward or downward direction.

Before I quit this part of the subject, I must make you acquainted with two other facts in connexion with the objective phenomena of strabismus. One is the difference in the apparent bulk of the two eyes; and the other is the condition of the pupil.

In a considerable proportion of those affected with strabismus, it will be found that the distorted eye is either somewhat more or less prominent than its fellow; and, in some instances that have fallen under

my notice, this has arisen from an actual difference in the bulk of the two organs, as ascertained by the measurement of their corneæ. The pupil of the distorted eye is also not unfrequently more dilated than the other, and less obedient to the stimulus of light. This, together with the impaired vision which so frequently accompanies the deformity, has given rise to the supposition that the eye is affected with amaurosis; and I have known persons subjected to a long course of mercurial treatment for the removal of this imaginary malady.

Having spoken of the objective phenomena of strabismus, I will now mention the subjective, and they are not less interesting than the former.

Subjective phenomena.—A distinction must be made between the phenomena which are present when both eyes are open, and those which are proper to the squinting eye only. The former are chiefly such as arise from the interference of the sensations of the squinting eye with the vision of the sound one, and consist either in a mistiness floating before the distorted eye, which confuses the vision of the opposite one, or the formation of a double image of the object gazed at. For instance, in threading a needle two holes will be perceived instead of one, and thus the accuracy of vision is destroyed. Both these phenomena are not unfrequently observed in the same individual. Thus, in one of

my cases, that of Mrs. Halliday, I have this note :
“ The impression made on the retina of the squinting eye interferes slightly with the vision of the other, so that she sees better with the bad eye closed than with it open. On my asking her if she ever saw double, she replied in the affirmative, and added, that one of the images was very faint and indistinct, ‘ a sort of shadow of the other.’ When holding up my finger before her, she saw it and ‘ its shadow,’ which latter is on the same side as the squinting eye.”

In the case of William Gray, a tailor, who was the subject of divergent strabismus, he is unable to thread his needle when both eyes are open, two holes being perceived instead of one, so that he is obliged to close the squinting eye before he can do so.

These phenomena, as already mentioned, are accounted for on the hypothesis that there are certain parts of the retina of both eyes which correspond with each other, and that for single vision it is generally necessary that the images of objects should fall on such corresponding points, otherwise they will be seen double. This imperfection of vision which squinters sometimes experience when both eyes are open, is, however, by no means an invariable result ; in fact, it is perhaps rather an exception to a general rule, than the rule itself ; a large proportion of those who squint experiencing no such inconvenience, so

feeble an impression being made upon the retina of the distorted eye, that the mind disregards it altogether.

I must now speak of the subjective phenomena which are proper to the squinting eye, *per se*.

In all cases of single convergent strabismus of which I have taken notes, the sight of the distorted eye was more or less imperfect. In the majority a want of definition prevailed, objects appearing misty and indistinct, and sometimes larger, sometimes smaller, and sometimes of the same size as they did to the sound eye. This indistinctness varied also in degree, and in some was so great as to prevent even the largest type being deciphered ; while, in one instance, no mistiness whatever was observed, but all objects appeared much diminished ; in some cases they were required to be held very near to the eye, as if it were myopic, while, in two instances, they were held considerably to its outer side. A convex lens improved the vision by magnifying the objects, so that print, the size of which was too small to be read by the naked eye, could be made out with the aid of the magnifier ; yet, even under these circumstances, it was never seen clearly, as with the other eye, the want of definition still remaining.

The cause and nature of the imperfection of vision I shall not allude to at present, as it will come under consideration when discussing the *causes* of the ob-

jective and subjective phenomena; I am now merely calling your attention to the phenomena themselves.

To the subjective phenomena of double convergent strabismus, allusion has already been made, when pointing out the difference between it and the single; I will, therefore, merely repeat here, that so far as my observations at present extend, the amount of imperfection of vision affecting each eye is generally less than that which exists in the distorted one in the single variety.

I will now read to you a few extracts from my note-book illustrative of the phenomena that have just been described.

Esther Walton, aged 17, has convergent strabismus of the left eye, the whole globe of which appears somewhat *larger* than the other, and is evidently more convex, the diameter of the two corneæ, I think, are not quite equal, but they are perfectly transparent, and the pupils are alike. She can move the eye freely in every direction, but not quite so much outwards as the other. The *sight* of the affected eye is very imperfect, she cannot even make out the large type of "DIFFERENT SIZES" in the "Author's Assistant," the letters all appear in a mist and magnified; when looking to the left side objects are sometimes seen double.

Georgiana Livermore, aged 11, has convergent

strabismus of the right eye, which is less prominent than the other ; but it is doubtful whether the whole globe is smaller, as the size of the corneæ in the two eyes appears equal ; both corneæ are clear, and pupils equally dilated and dilatable. She can move the eye freely in all directions, but to a less extent outwards than the sound eye ; and to a greater extent inwards than the same. *Vision* in the squinting eye is imperfect, objects appear to it smaller and less distinct than to the other. With great effort she can make out a word or two in the *brevier* type, but not in the *nonpareil* ; a convex glass magnifies the objects and makes them clearer. In reading, the images on the squinting retina are not attended to, and consequently they do not interfere with the vision of the other eye. She never sees double.

Emma Trip, aged 14, has a cast of the left eye, *upwards* and *inwards*. In viewing objects moved before her both eyes follow it, but their axes differ somewhat. She can move the eye outwards to a somewhat less extent than the other ; but inwards to a greater extent. The pupil and cornea are alike in both eyes. This patient sees perfectly well to read the smallest print when both eyes are open, and closing the squinting eye produces no difference, *but she cannot distinguish the largest type with the left eye*. On using them for a long time to-

gether, vision becomes indistinct and misty ; the objects appear double, and her eyes ache.

The rationale of these phenomena will involve a consideration of the *immediate and remote causes of strabismus* ; these, however, I must defer speaking of till my next Lecture.

LECTURE III.

ON THE REMOTE CAUSES OF STRABISMUS.

GENTLEMEN,

THE causes which give rise to strabismus may be divided into the immediate and the remote. By the former term is meant the actual or immediate power by which the distortion is produced, and this in most cases resides in the orbital muscles ; one of these may have become stronger, or weaker, or shorter than the others, and their equilibrium being thus disturbed, the eye becomes distorted.

The remote causes are those which have brought about these changes in the muscles, and they are to be sought for in the nerves of the orbit or the nervous centres with which they are connected. I will now proceed to enumerate some of the remote causes.

First among these may be placed certain *congenital defects of the organ of sight*, such as deficient sentient power in the entire retina of one eye ; or the limitation of sensibility to one part of this membrane, and that, not in the axis of the eye, but at some other

point excentric to it ; or, again, great inequality in the focal power of the two eyes.

From any of these causes the muscles of the eye affected would be deprived of the controlling or guiding power of sight ; so that its movements would become passive and obedient only to the volition exerted on the sound eye.

Such a condition is probably favourable for the production of strabismus, and hence defect of the visual power of the eye has always been regarded as one of the predisposing or remote causes of this affection, indeed the very large proportion of cases in which defective vision accompanies strabismus is sufficient to prove that a close relation exists between them. Previous to the introduction of the operation of dividing the internal rectus, it was generally believed that the squinting always resulted from the defective vision, of an effort, as it were, made upon the part of the patient to move the eye out of the axis of vision, that it might not interfere with the impressions excited on the retina of the sound eye. But the operation in question has been a sort of *experimentum crucis*, by which we have learnt that, in many cases, the impaired sight is the effect and not the cause of strabismus ; the operation not only restoring the symmetry of the two eyes, but equalising their visual power.

Next, among the remote causes, may be enumerated the various *diseases of the brain* which are so preva-

lent at an early period of life ; such as hydrocephalus, scrofulous tubercles and ramollissement, also the convulsions, which sometimes attend these diseases, or are brought on by irritation propagated to the brain from other parts of the system, as the intestinal canal, or the gums during the period of dentition.

In all these diseases the orbital nerves are liable to suffer either at their central extremities, or at some other part of their course : and this would necessarily be followed either by paralysis or spasm of the muscles to which they are supplied. But strabismus has sometimes been observed to result from a violent fit of coughing, such as frequently occurs in hooping-cough, paroxysms of rage or passion ; and severe frights have likewise given rise to the deformity.

In these examples it has been surmised that the lesions are of an apoplectic character, and, though slight and evanescent, yet sufficient to disturb the balance of power of the orbital muscles.

Now whether the defect or the disease which has given rise to the strabismus, occurred during the period of foetal existence, or subsequent to birth, in either case it may have arisen from inherited predisposition ; the parents of the individual suffering from strabismus being themselves so affected, hence, *hereditary tendency* is always enumerated among the remote causes of strabismus.

Some writers, however, have called in question

the efficiency of this cause in the production of the deformity. Mr. Lucas, in particular, attributes all such examples to the influence of imitation. "All children," he observes, "have a propensity to imitate those they are much with, as their parents;" and in confirmation of this opinion, he states, that he has observed it more frequently in children whose mothers squinted, than in those whose fathers were affected with this obliquity. He observes, also, that the children of squinting parents are themselves frequently free from the deformity; and, again, that many parents have children who squint, while they themselves are unaffected. This is an objection that would apply equally to the hereditary transmission of any other disease, and has no more force in that of which we are now treating than in others.

That imitation is a very fruitful source of strabismus, I am quite prepared to admit, and many children may thus derive it from their parents, but it is as certainly unphilosophical as it is untrue to deny the influence of hereditary tendency as a remote cause.

My note-book furnishes me with numerous examples of strabismus thus acquired, in which the influence of imitation is obviously excluded by the fact that the parents were affected with a squint in one direction, while their offspring had it in the opposite. In other cases, the children were too young to

have contracted it from such a cause ; thus, in Emma Trip it came on when she was only twelve months old.

I have now to speak of those remote causes of strabismus which are independent of cerebral disease, or imperfect development of the organ of vision, but arise from an *excess of nervous force*, directed to certain muscles, through the medium of volition.

Under the latter head may be grouped all those cases which owe their origin to *imitation* and *ophthalmia*.

That *imitation* is a very frequent source of strabismus, I have already remarked ; and I entertain no doubt whatever of its efficiency in the production of the deformity, notwithstanding that the contrary opinion has been maintained by several writers on this subject, who, arguing on the insufficiency of the cause to produce such an effect in the adult, would exclude it altogether from the category of remote causes. But it by no means follows, that because such an effect would not be produced in a grown-up person, that therefore it would not in a child. In the latter, it must be remembered, that all the organic functions are carried on with more rapidity than in the former, growth, as well as nutrition, having to be provided for ; and in whom, therefore, it is reasonable to believe, that the frequent use of one muscle, or its continued contraction for even a short

period, would necessarily divert to itself a larger quantity of nervous force, and vascular activity, sufficient to render it more powerful than its antagonist, or even to stamp upon it the character of permanent shortening. That parents not unfrequently, and indeed not unnaturally, attribute the defects of their offspring to causes which have had no existence, most of you, no doubt, have been witnesses to, as in those defects called mother-spots or mother-marks, and the same kind of feeling may probably induce them to attribute the deformity in question to imitation, when it may have arisen from a different cause.

But the instances of squinting, occasioned by imitation, are far too numerous to be all of them thus accounted for ; for example, Mr. Hall, in an analysis of more than two hundred cases, found that about one-fifth of the number, in which the patients or their parents were able to assign any cause, ascribed it to this source ; besides which, there is a good deal of collateral evidence which tends to support this view. Thus, Mr. Lucas relates an interesting case of a young gentleman, fourteen years of age, who had strabismus for two days, in consequence of his endeavouring to pass a thread through a small hole in the clavicle of a fowl, which he had placed across the bridge of his nose. He succeeded in his attempt, but was rewarded with strabismus, which, fortunately,

was not of a permanent character. It is not unlikely that, had this young gentleman repeated the feat, the deformity would not thus have disappeared.

The *modus operandi* of *ophthalmia*, as a remote cause of strabismus, may be similarly explained. "A child," says Mackenzie, "has an ulcer on the cornea ; he finds, by a particular effort of the muscle, he can so turn the eye as to ease the pain attending the friction of the ulcer, in the natural movements of the organ. This effort is attended by a squint ; and by frequently repeating the effort or almost constantly employing it for a time, an habitual strabismus is formed ;" or it may arise in a different way—the ulcer has healed, but has left an opacity which interferes with the passage of the direct rays of light to the retina. To counteract this the patient voluntarily turns his eye in such a direction as to allow these rays to pass through the more transparent parts. The internal rectus being thus continually exerted acquires increased strength ; the balance of power of the muscles is disturbed, and permanent obliquity results.

I fear that the strabismus which follows *ophthalmia* is sometimes produced by maltreatment of the surgeon, or of the parents of the child. The affected eye is kept bound up, and on subsidence of the inflammation the child is found to squint. A very instructive case of this description lately came under my observation at the public dispensary.

A little girl, three and a half years of age, was brought to me on the 5th of April, 1853, with a scrofulous ulcer on the left leg, and another on the arm ; both shortly healed under the treatment adopted, when some impetiginous pustules made their appearance on the scalp, and at the same time the left eyelid became affected with a phlegmous inflammation which completely closed the eye. This was on the 22nd of April, and previous to this date both eyes were perfectly healthy and free from distortion. Exactly one month after this, the lid had nearly recovered its usual healthy appearance, the pustules had disappeared from the scalp, and her general health had much improved, but she now squinted badly with the eye, the lid of which had been inflamed, and at the present date (January) the eye continues permanently distorted.

While I was reflecting on the probable cause of the deformity, in the case just cited, and considering the means that might be adopted for remedying it without operation, I accidentally discovered the cause sooner than I expected. I directed the mother to bind up the sound eye for a week, and then bring the child to me ; when she hesitated, and seemed to demur to my directions. On asking the reason of her hesitation, she told me that she had of her own accord, bound up the squinting eye when its lid was inflamed, and that she considered the squint had been brought on by her having done so ; and she

feared that if she were to do the same with what was now the straight eye, that that one would likewise become distorted. And she then explained to me, that while the bandage was over the inflamed eye she had observed the child was always trying to make use of that eye, by looking inwards, and out of the way of the bandage.

The cases which I have just related clearly point to excessive muscular action as a cause of strabismus, and afford that collateral evidence in favour of imitation, to which I have before made allusion.

The frequent occurrence of strabismus after attacks of inflammation of the eye is, however, suggestive of another explanation than that just given:—that it may, in fact, in some cases, be not only the exciting but the immediate cause of the deformity by giving rise to adhesion between the eyeball and some of its coverings, in which one or other of the muscles may become involved, just as we find contractions of the fingers or toes not unfrequently follow inflammation of the hands or of the feet.

This view of the question would afford a satisfactory explanation of the occasional failure of the operation to rectify the deformity, notwithstanding the internal rectus muscle has been completely divided.

In corroboration of this opinion, I may mention a case related by Mr. Duffin, of a female, whose cornea bore evident marks of previous long-continued in-

inflammation, on whom he operated for strabismus, and found all the investing structures of the inner periphery of the eye, so "thickened, contracted, and infiltrated, that they cut like cartilage." He also relates an interesting case of a lady who had been twice couched for cataract, and who, after each operation, suffered from severe inflammation of the eye.

This lady informed him, that the strabismus with which she was previously affected had been considerably increased, and the freedom of motion of the eyeball much diminished by the inflammatory attacks. The same adhesions of muscular, tendinous, and cellular tissue, were found in this case, as in the former.

There is one class of cases of strabismus which, so far as I am aware, has not been described by any writer except Mr. C. Radcliffe Hall. This gentleman, in an interesting paper on the subject in the "London Medical Gazette for the year 1841," has called the attention of the profession to certain instances in which strabismus has appeared to result from an hypertrophied condition of the inner rectus of the sound eye, while the corresponding muscle of the squinting one presented no abnormal enlargement; and when the strabismus affected both eyes, the least distorted was that in which the internal rectus was enlarged; and the most distorted, that in which it

presented only its natural dimensions. In all these examples it was found that the vision of the eye that squinted, or that squinted most, was very considerably inferior in power to that of the other ; necessity would thus be laid upon the good eye to perform all the principal offices of vision, and its abductor muscle, being thereby continually called upon to counteract the tendency of its powerful antagonist to produce inversion, would lead, Mr. Hall imagines, through the tendency to consensual action of the two eyes, to inversion of the weaker organ.

The remote cause in these cases differs somewhat from that to which we have previously referred, as arising from an imperfectly developed organ or impaired vision, inasmuch as the inversion would appear to be due, not to the defect of vision in the squinting eye, but to the *hypertrophied condition of the abductor muscle of the opposite*.

There is one fact more to which I must advert, viz., the occasional occurrence of strabismus in an eye which was previously straight on rectifying its fellow which squinted ; so that the *rectification of a squinting eye* must, to a certain extent, be regarded as a remote cause of a similar affection in the opposite one.

I am aware that some writers have attempted to invalidate this conclusion by affirming that the strabismus originally affected both eyes, though in an

unequal degree, and that the inversion of the supposed straight eye is only rendered more apparent by contrast with that which has been rectified by the operation.

Admitting the truth of this in some instances, I, at the same time, consider it undeniable that the straight eye in certain cases of single convergent strabismus does become inverted after its fellow has been rectified by operation, and in consequence of such rectification which must therefore be regarded as a remote cause of strabismus.

The rationale of this phenomena is probably that suggested by Mr. Hall, viz., that the sensorium, having been long accustomed to receive direct rays from one eye and oblique from the other, experiences some degree of confusion on receiving them in the natural but unaccustomed manner; an effort is therefore made to restore the former abnormal condition of vision by inverting the sound eye, and thus the strabismus, instead of being removed by the operation, is merely transferred from one eye to the other. Having enumerated the principal of the remote causes of strabismus, I will defer speaking of its immediate or proximate cause till my next Lecture.

LECTURE IV.

THE IMMEDIATE OR PROXIMATE CAUSES OF STRABISMUS.

GENTLEMEN,

IN my last Lecture I endeavoured to class the remote causes of strabismus according to their origin ; first, in congenital or other defects of the organ of vision ; secondly, in disease or irritation affecting the nervous centres or orbital nerves ; and thirdly, in the over action of certain muscles voluntarily produced for the purpose, either of improving vision, relieving pain, or from mere wantonness, as in the imitation of others affected with squinting.

These causes produce changes in the muscles implanted into the eyeball, by which their balance of power is disturbed, and the harmony of their movements destroyed, so that strabismus is the consequence.

The mode in which impaired vision produces strabismus is not easy of explanation, and I must confess my inability to offer a satisfactory solution of the problem.

It is not improbable, that the defect in the organ

of sight may be accompanied by some slight inequality of power between the internal and external rectus ; and the function of the organ being suspended, it ceases to exercise any controlling action on the muscles by which it is moved, so that it becomes abandoned to the influence of the more powerful muscle, and an internal or external squint may be thus produced.

Mackenzie suggests, that there may be even “an instinctive attempt in some cases still further to distort the weak eye ; and to turn it so far inward and under the upper lid, that no impression can be received upon it, but that the sound eye only shall become the instrument of sensation.”

I am the more disposed to consider that there is some concomitant affection of the muscular apparatus of the eye in these cases ; because we do not find that cataract affecting one eye is followed by any distortion, which, on the hypothesis of impaired vision being the cause, should not unfrequently result.

Whatever may be the correct explanation of the phenomenon in question, it may be assumed, without much fear of contradiction, that the muscle immediately engaged in the deformity must be either stronger or shorter than its antagonist, or the latter may be actually or relatively weaker than that of the opposite eye.

The changes produced in muscle by disease or

irritation of the nervous centres or nerves, are of two kinds; first, paralysis; secondly, spasm; and these, if of long continuance, terminate in atrophy in the one case, and structural shortening in the other.

Strabismus arising from *paralysis*, I believe to be of comparatively rare occurrence, as proved by the fact, that most squinters possess the power of moving the eye from its unnatural position, to the extent of producing some slight degree of eversion, and, in some instances, to evert it to the same extent as the sound eye. It is clear, therefore, that the abductor muscle cannot be paralysed, notwithstanding the opinion of many respectable authorities to the contrary. It is true, they qualify the expression somewhat by terming it partial paralysis or defective power; and if by this is meant that it is weak relatively to its antagonist, I am quite willing to go along with them, but when they affirm that this weakened condition of the abductor muscle is the cause of squinting, I must express my total dissent from such a statement.

The theory which attributes strabismus to a weakened state of the abductor muscle, derives its chief support from the fact, that after division of its antagonist for the cure of this deformity, the eye is only straightened, and not everted, as it would be, say the advocates of this theory, did the abductor possess its normal power, and they appeal to the eversion

which follows the accidental division of the internal rectus in a healthy eye, as well as to that which is the result of paralysis of the same muscle, in confirmation of their opinion.

These arguments are more specious than sound. That the external rectus of an eye affected with convergent strabismus of any standing, is in most instances weaker than the corresponding muscle of the opposite eye, there can be no doubt ; but that is not the point in question. What we want to know is, was it so *before* the squint occurred, and did the distortion arise in consequence of such weakness ? In other words—is it the *cause* of strabismus, or only the *effect* ? I believe it to be the latter, and for the following reasons :—

1st. Many cases are met with in which the external rectus of the squinting eye possesses the power of everting it to the same extent as the corresponding muscle of the sound eye.

2nd. In those cases in which the division of the internal rectus fails at first to rectify the squint (apparently from the weakened condition of the external rectus consequent on disuse), the latter muscle very soon regains its power, from the more favourable condition in which it is placed by the division of its shortened or too powerful antagonist, and the eye is then drawn into the centre of the orbit.

3rd. It very seldom happens, when the operation

for the cure of convergent strabismus is properly performed, that the squint returns ; which it most certainly would do were the abductor muscle weaker than its antagonist, now re-united to the eyeball.

4th. The distortion which arises from complete paralysis either of the external or internal rectus is seldom so great as it is in those cases in which no paralysis exists. This latter fact appears to me to set the question at rest as regards a weakened state of the external rectus being the usual cause of squint ; for if the degree of inversion be greater where the external rectus is unparalysed than it is where the same muscle has no power whatever, but is completely paralysed, it is clear that the most potent cause of strabismus is certainly not the weakness of the abductor muscle.

In confirmation of this opinion I may refer to certain cases of congenital club-foot, in which the contraction of the muscles which produced the deformity is not the consequence of disease, but simply of mal-position in utero. In these cases the antagonist muscles are elongated and weak, but quickly recover their normal bulk and strength, which the mal-position only had deprived them of, on dividing the tendons of the shortened ones.

I cannot admit, therefore, that a weakened condition of the external rectus is the usual cause of strabismus. In making this statement I do not deny

that it may not be an occasional one, all I contend for is that it is of much less frequency than many writers would have us to believe.

Having said thus much, I will now relate to you a case of strabismus, which was undoubtedly attributable to this cause,

James Palmer, 30 years of age, a compositor by trade, applied to me at the public dispensary, March 6th, 1847, for a convergent strabismus of the left eye, on which he wished me to perform an operation for its removal. He stated that it interfered so much with the vision of the other eye as to incapacitate him for his ordinary business. This, however, he had remedied to a certain extent by binding it up, so that he was, to all intents and purposes, blind with that eye, and the whole of the work was thrown on the undistorted one. This he imagined rendered it weaker, and made him somewhat anxious lest the sight of this should suffer in consequence, and was the reason for his wishing me to operate.

On examination I found it to be a case of *Lusctas*, which differs, you recollect, from ordinary strabismus, inasmuch as in the latter the patient can move the distorted eye without difficulty from the inner canthus to a central position, and sometimes even evert it to the same extent as he can the sound eye ; whereas in the former, the patient possesses no power of everting the eye in any degree, so that it remains fixed in its unnatural position.

A further examination of the patient showed that the strabismus arose from complete paralysis of the external rectus muscle, not from any spasm or shortening of its antagonist. He could invert the eye to the same extent as the other, but could not evert it, or even bring it into the central axis of the orbit; the cornea, when not acted on by the internal rectus, occupying a position midway between the centre of the eyelids and the inner canthus. The upward and downward movements of the eye were not impaired.

What renders the case more interesting, as well as places beyond a doubt the cause of the deformity, there was also complete paralysis of the left half of the tongue. On thrusting it from the mouth, its point deviated to the left side; but the most striking appearance connected with this organ was its want of symmetry, the left half being broad, flat, and flabby,—in fact, atrophied; whilst the right was plump, firm, and roundish.

Now the nerves supplying the abductor of the eye and the genio-hyoglossus of the tongue are the sixth and the ninth; both of these arise near together from the motor track of the medulla oblongata. The patient had, in fact, been the subject of syphilis, had had ostitis of both tibiæ, and suffered continual pain in his head and back of his neck. This led me to believe that the occipital bone had participated in the disease, and the two nerves, just named, which are

in contact with the basilar process of that bone, were probably affected secondarily.

My experience leads me to believe that the bones of the base of the skull, though less liable to be affected by the venereal poison than those which form its roof, are yet sometimes the seat of this specific inflammation; and where this happens, the nerves of the base which are in contact with those portions become to a certain extent implicated.

I need scarcely remark that I declined the operation, and subsequently had the satisfaction of watching the gradual disappearance of the strabismus from the influence of the remedies I prescribed for the syphilitic affection.

Here then is a case in which the squint was produced by palsy of the abductor oculi muscle consequent on disease affecting the sixth nerve.

In one of the earlier volumes of the "Pathological Transactions," will be found a case related by Mr. Partridge, in which dissection revealed a small tumour connected with the abducens nerve, thus causing paralysis of the external rectus muscle. It was that of a man, 30 years of age, who had squinted badly from childhood, and whose eye participated but slightly in the movements of its fellow. The external rectus muscle was elongated and much attenuated; the internal rectus was short, bulky, and had a much thickened tendon, scarcely differing

in appearance from cellular tissue ; while the other orbital muscles were of their ordinary size, though a little paler than natural. Under the microscope the muscular fibrils, except those of the levator, appeared to be made up of mere granular matter enclosed in the usual sarcolemma sheaths, only here and there a few striped fibres were observable, and in the internal rectus they were scarcely to be detected. All the branches of the third nerve were healthy ; the sixth, just after its entrance into the orbit, had a light gray semitransparent look, and in its trunk was an oval enlargement, about the size of a pin's head.

Cases of divergent strabismus produced by palsy of the adductor muscle are more frequent. Here is one, which I will read from my note-book ; it has been very carefully taken, and illustrates some other phenomena connected with this description of cases, to which I have already alluded in my Lecture on the Muscles of the Eyeball.

Mrs. Brooks, aged 44, has paralysis of all the muscles of the left eye supplied by the third nerve. On placing myself directly opposite to her, and on the same level, so that my eyes were on the same horizontal level as hers, she was directed to look straight at me, and on raising the lid of the affected eye (there was ptosis) the following was observed :—

The cornea was drawn outwards, towards the external canthus, but no portion was hidden by it ; it

was not quite on the same horizontal level as the cornea of the other eye, but rather higher, a small part of the sclerotic being visible between its lower edge and the inferior palpebra. The pupil was widely dilated and immovable, and the sensibility of the retina was evinced by the abundant lacrymation. No difference in the prominence of the two eyes was observed, nor was any bulging of the globe perceptible. She could, by a voluntary effort, evert the eye to the same extent as the other, and on discontinuing the effort it returned to the position above described. It could not be turned further inwards than this, nor upwards nor downwards even in the slightest degree ; neither upwards and outwards, nor downwards and outwards ; but on telling her to look downwards the eye was rotated on its antero-posterior axis by the superior oblique ;* the upper part of the globe being drawn very slightly forwards, and perhaps inwards, so as to give to its lower part an opposite inclination. On directing her to look upwards, after looking downwards, the globe rotated in an opposite direction. On inclining the head by turns to either shoulder, nothing could be made out.†

* This action of the superior oblique may always be observed in cases of paralysis affecting the third pair of nerves, and was first pointed out to the profession by Dr. Jacob of Dublin.

† If a healthy individual gaze steadily at an object in front

On holding up the paralysed lid, and telling her to shut her eyes, the cornea was pushed from the external canthus into the centre of the orbit, and

of him, while his head is inclined to either shoulder, the vertical axis of his eyes will still be maintained in a vertical direction, and will, therefore, form an angle with the inclination of the head. This maintenance of the vertical position of the eyeball under these circumstances is due to the oblique muscles. Now if either of these muscles be affected with paralysis, the vertical axis of the eye in which it occurs will no longer correspond with that of the head when erect, or with that of its fellow of the opposite side, but will form an angle with it; in fact, a squint will be produced, though for obvious reasons, it will not be observed. If each obliquus in its healthy condition can roll the eye round its antero-posterior axis to an extent of 45° , we may assume that if one of them be paralysed its antagonist will produce a distortion of the eye equivalent to at least 20° ; or, in other words, the vertical axis of the eye whose muscle is paralysed will no longer coincide with that of its fellow, but will form an angle with it of the size just mentioned. To apply these facts to the case above narrated: a line corresponding with the vertical axis of the left eye would have its upper extremity internal, and its lower external, to a perpendicular, that being the direction which the superior oblique would give it when unopposed by its paralysed antagonist, the inferior oblique. On inclining the head to the left shoulder, the vertical axis of the eye would become vertical when the head had attained an inclination of 20° , and it would be maintained in this position, by the action of the superior oblique, till the inclination of the head had reached 65° .

On inclining the head to the opposite or right shoulder, no

the whole globe very sensibly depressed, by the orbicularis. From the want of intelligence in the patient, it was difficult to make out much in reference to vision. Two things, however, were certain ; first, that all objects appeared enveloped in a thick fog ; and, secondly, that they were diminished. It was not satisfactorily ascertained whether they were rendered clearer by a convex glass, whether the focal distance of the two eyes was the same, or whether double vision was observed on inclining the head laterally.

These phenomena are easily explained. The levator muscle of the upper lid, and the superior, inferior, and internal recti, together with the inferior oblique muscle, were paralysed. These muscles are all supplied by one nerve, the motor oculi or third, whereas the external rectus receives its nervous supply from a different source, and was not implicated in the disease which affected the other, the muscle that it supplies remained therefore unparalysed, consequently the eye was drawn outwards.

The distortion in the foregoing instances is precisely analogous to the distortion of the whole face which movement of the left eye round its antero-posterior axis would take place, owing to the paralysis of the inferior oblique muscle ; consequently, the vertical axis of the eye could not be maintained under this movement, but would correspond with that of the head, plus the 20° given to the former by the passive contraction of the superior oblique.

occurs in facial paralysis from disease affecting the portio dura of one side.

Strabismus arising from *spasm* is rather to be inferred than demonstrated; and under this head may be included the majority of those cases that are obviously not induced by paralysis on the one hand, or hypertrophy from over action on the other; as for example, the strabismus which arises in consequence of convulsions, or from the irritation of teething, or from intestinal irritation; and I should be disposed to believe that such cases are eventually followed by structural shortening of the affected muscle, which would prevent the eye from being fully everted. Such appears to have been the origin of the strabismus in the following case:—

Mrs. Baker, aged 37, and the mother of four children, all of whom are free from the deformity, has convergent strabismus of the left eye, of a very decided character, but no difference is observable in its prominence, or in the size of its pupil, as compared with that of the other eye. When she looks to the left, the good eye is much more inverted than it ought to be, while the squinting one is not sufficiently everted; and thus it happens that the sound eye seems to squint while the other appears unaffected. On looking straightforwards the unaffected eye immediately assumes a position midway between the external and internal canthi of the

eyelids, while the other becomes strongly inverted. The motions of the sound eye outwards are natural, but inwards more than natural. The motions of the squinting eye outwards are only just beyond the centre of the orbit, but inwards they are very great, the external and internal edges of the cornea looking forwards and backwards. The *vision* of the squinting eye is always misty, even when the letters are magnified with a lens ; without this the patient can only make out with difficulty the letters one by one, of DIFFERENT SIZES, in the “ Author’s Assistant ;” whereas, with the other eye she can read the nonpareil type fluently. Objects are best seen with the bad eye when they are held exactly opposite, and at about the ordinary reading distance ; when held to the left of the eye they disappear. The patient never sees double, nor does the bad eye at all interfere with the vision of the other. When a finger is held up before the squinting eye, the other being shut, it is seen ; but on opening the good eye, it is seen better, the squinting one retiring into the inner canthus, and taking no further trouble about it.

History.—She has been the subject of strabismus from infancy, and heard her mother say it came on while she was cutting her teeth.

Without dwelling any longer on this description of cases, of which my note-book furnishes me with numerous examples, I will pass to those in which the

squint is obviously caused by *increased power and bulk* of one of the recti muscles, most frequently the internal rectus.

The history of strabismus, as well as the phenomena, both point to this condition of muscle as one of the most frequent causes of the affection ; all those cases, therefore, which arise from imitation—from bandaging up the affected eye—from looking at some spot on the nose—from ulceration, or central opacities of the cornea—from misplaced pupil—and from misplaced retinal sensibility, are probably owing to this condition of the internal rectus muscle. The *modus operandi* of squinting thus produced, is easily and satisfactorily explained on the hypothesis of over action, or very frequent action, of the muscle increasing its strength and bulk ; and this change having resulted, the external rectus is overbalanced, and the eye becomes permanently inverted.

Now, the fact of the eye being thus given up to the action of the more powerful muscle, will also explain why the external rectus becomes weaker ; it is seldom called upon to act, so that it probably becomes smaller and somewhat atrophied, and in this manner the deformity is perpetuated.

The statements I have just made are not mere conjectures, or *à priori* reasonings of what might be expected to follow such undue action as I have just spoken of, but they are confirmed by analogous ex-

amples which are met with in other parts of the body, by actual observation of the condition of the muscles during the operation, and by dissections performed after death.

The increase of strength and bulk of muscle in consequence of increased action, is a fact too familiar to all of you to require my dwelling upon at any length on the present occasion.

In no organ of the body are the changes we are speaking of, so frequent or so decided as in the heart.

A post-mortem is being made of a man who has died from dropsy ; you are told that it is in consequence of heart disease, and, upon examining that organ, you find that some contraction has taken place at one of the orifices ; we will suppose, for instance, at the orifice of the aorta, or pulmonary artery, and to overcome the obstruction the heart contracts with more force than formerly, and, in consequence of this over action, its walls have become greatly thickened and its power augmented. Here is one of the many specimens which our Museum contains in which this result is well seen. But it is unnecessary to occupy your time further by analogous illustrations ; the fact of the increased power and bulk of the internal rectus muscle in cases of convergent strabismus, is matter of notoriety to all who have undertaken operations for its removal, and such few dissections as

have been made of squinting eyes mostly go to confirm this fact. Mr. Middlemore relates three cases in which he had an opportunity of dissecting the eyes of squinters; one was that of a young child five years of age, who had external squint of the right eye, and he found the abductor muscle much enlarged, as compared with the other orbital muscles of the same eye, as well as with that of the corresponding rectus of the opposite one.

He also relates another case of considerable interest in the present inquiry : that of a young man he was called to, for a burn on the outer part of the eye, by which the conjunctiva oculi became adherent to that lining the lids near the outer canthus ; so that the movements of the eye were much impaired thereby and an external squint produced. By the frequent and strong action of the internal rectus, these adhesions were at length overcome ; and he was able to move the eye inwards, nearly to the same extent as the other. Shortly after this he died, and Mr. Middlemore embraced the opportunity thus afforded him of examining the muscles of the orbit. The internal rectus was found to be much enlarged and thickened, and very strong.

A third instance occurred in an individual who had suffered long from what Mr. Middlemore terms neuralgia bulbi ; in consequence of which the eye was spasmodically and continually darted from side to

side, and in various directions. This patient also died, and the muscles were found to be extraordinarily developed.

I have already made allusion, when speaking of the remote causes of strabismus, to those curious cases of hypertrophy of the inner rectus muscle of one eye, which produce inversion of the opposite eye in which the same muscle is of its natural size ; and I have nothing more to say on this subject on the present occasion.

There are some cases of strabismus which cannot be satisfactorily accounted for on any of the hypotheses already alluded to ; they are those in which dissection has revealed no trace of alteration of structure or bulk of the nerves or muscles of the orbit ; these are, perhaps, the cases in which during life-time, the individuals exhibited no want of power of any of the orbital muscles, the eye being capable of rotation in every direction to the full extent possessed by those who are unaffected by the deformity. In the first volume of the "*Journal Hebdomadaire des Progrès des Sciences Medicales*," will be found an interesting case by Dr. Cavarragh, who dissected the muscles, nerves, and blood-vessels of the eye of a young man who squinted, and found no disease or alteration about any of them, but the crus cerebelli on the same side as the strabismus, presented a loss of substance to the extent of some lines.

Now you know very well that this portion of the encephalon is a commissure, by which the cerebellum is brought into relation with the cerebrum and the medulla oblongata, and all the experiments that have been made with the view to determine the function of the cerebellum, as well as many facts in pathology and comparative anatomy, go to prove, that it is the regulator or co-ordinator of the muscular movements. Lesions of this portion of the encephalic mass do not paralyse the muscles, which remain obedient to the stimulus of their nerves, whether excited by mechanical or artificial means, or naturally by volition : only the power by which these actions are regulated and made to combine to produce a certain result is wanting.

If the strabismus which arises from an inequality of power of the orbital muscles has its analogue in the several varieties of club-foot ; that of which we are now speaking may be allied to stammering and some other affections manifested in perverted muscular action.

LECTURE V.

ON THE CAUSES OF THE SUBJECTIVE PHENOMENA OF
STRABISMUS.

GENTLEMEN,

IN my last Lecture I adduced evidence to show that strabismus may be due to at least three pathological conditions of the recti muscles: viz., paralysis; spasm, with structural shortening; and hypertrophy; and I suggested that certain examples of the affection in which no pathological change was observable in the orbital muscles or nerves, might arise simply from perverted action, the result of some lesion affecting that part of the encephalon which we presume to be connected with the controlling or the co-ordinating of muscular actions.

It has been imagined that strabismus may sometimes be occasioned by the obliqui muscles. The error originated from observing that division of the internal rectus was not always followed by the result anticipated; the eye still remaining too much inverted. The real cause of this want of success I shall explain to you when I come to speak of the

treatment, and must refer you to my Lecture on the actions of the obliqui muscles for the refutation of this error.

With regard to contractions of the ocular fascia as a cause of strabismus, I have already expressed my opinion that they may occasionally produce such a result : I will not, therefore, now occupy your time by repeating what I have already said on the subject.

An interesting question suggests itself in connexion with the pathology of strabismus, viz., why is the distortion, in nearly every instance, either in the outward or inward direction, and not upwards or downwards.

Conjectures only can be offered on this point. It may be owing partly to the greater power and size of the internal and external recti, as compared with the other orbital muscles : and partly to the state of antagonism that naturally exists between the former ; one being supplied by the third, and the other by the sixth nerve : whereas the other recti receive their nervous supply from one and the same source.

If the divergent and convergent varieties of strabismus far exceed in frequency distortions in any other direction, so does the convergent greatly exceed the divergent. Thus in Mr. Hall's 213 cases, thirteen only were divergent, nineteen were double convergent, and all the others, single convergent : the left eye being

exclusively affected in 110 cases, and the right in seventy-one.

For this greater frequency of internal strabismus we must perhaps seek an explanation in the anatomical relations and physiological uses of the adductor muscles.

You have already seen that they are naturally the most bulky of the orbital muscles ; that they are broader at the point of their insertion into the sclerotic, and nearer to the cornea, while the distance between their insertion and that of the superior and inferior recti, is less than that between the external recti and the two muscles just named. Hence the latter would contribute somewhat to produce inversion of the eye ; while eversion has to be accomplished by the unaided efforts of the external rectus. Again, the branch of the third nerve which enters the internal rectus, is somewhat larger than that of the sixth which supplies its antagonist ; the former must, therefore, have more numerous connexions with the encephalon, which alone would render it more liable to participate in its diseases. When it is recollected also that both the superior and inferior recti are supplied by branches of the same nerve, you can readily conceive that the liability of the internal rectus to derangement, from affections of the encephalon, must be nearly threefold greater than that of its antagonist, the external rectus. Again, the internal recti are,

perhaps, more constantly in action than any of the other orbital muscles, some slight degree of convergence of the eyes being necessary in viewing all objects not placed at considerable distances ; and the convergence being increased in proportion to the nearness of the objects regarded. Thus a greater amount of the vis nervosa is directed to these than to the other muscles, which again would render them more liable to derangement.

Sir Charles Bell, who attributed convergent strabismus to a weakened state of the external rectus muscle, endeavoured to show that the latter is more liable than any other of the orbital muscles to suffer from disorder of other parts of the system, as the digestive organs, &c., owing to the connexion of the sixth nerve, which supplies it, with the sympathetic system. But this argument loses its force when one recollects that the sympathetic also communicates with the third nerve, as well as with the fourth, so that in point of fact, all the orbital muscles communicate with the sympathetic by means of their nerves.

I have now arrived at one of the most difficult, though most interesting, parts of my subject, viz., the *cause of the impaired vision* ; this, I believe, will be found to vary in different cases. Impaired vision, as you are aware, may result from a variety of causes, and may have its seat in various parts of the optical apparatus—thus, taking the structures of the

eye in their order from before backwards : the cornea may be affected with opacities ;—the pupil may be closed by lymph, forming what is called false cataract : the lens, or its capsule, may have lost their transparency, constituting true cataract :—the vitreous humour may have undergone some change rendering it unfit for its function : or the sentient parts of the organ of sight, the retina, the optic nerve, or the brain, may be affected with disease. Now any one, or all of these lesions, may interfere more or less with the function of the organ, and impaired vision result.

But imperfect vision may exist without any actual disease, either functional or organic, of any of the structures just enumerated. Simply, the focus of the eye may be too short or too long, from its dioptric parts,—the humours being too much or too little refractive ; or these parts may be perfect, and the focussing power, or the power by which the eye adapts itself to view objects distinctly at different distances, may be defective. To some one or other of these causes the imperfect sight of the strabismic eye may be owing. I shall, therefore, now proceed to determine, if possible, to which of these it is due, and proceeding, as the French would term it *par voie d'exclusion*, I may at once dismiss from this category of causes—corneal opacities, false and true cataract, and limit my inquiries to the condition of the dioptric and sentient parts of the organ of vision.

With reference to the sensient parts, it is supposed by many that the impaired vision of the squinting eye arises simply from *disuse* of the organ; while others have attributed it to the *optic nerve being in some way implicated* by the recti muscles, which are partly connected with its sheath; others, again, imagine that the *same cause which produced the distortion* of the eye, may, in some instances, have affected the optic as well as the motor nerves of the orbit.

Those who attribute it to *disuse* of the eye, refer, in support of their opinion, to the improvement which is observed to follow its rectification by operation; but the fact which militates most strongly against this opinion is, that the improvement is *immediate* on division of the muscle which produced the deformity; whereas, on the hypothesis of disuse of the eye being the cause of the impaired vision, some length of time would be requisite for the restoration of the sight; besides which, we do not find that cataracts of many years' standing have this effect, although the function of the retina may have been suspended for a long period; on the contrary, no sooner is the obstacle to vision removed by the operation, than the visual power of the eye is at once restored. Disuse, therefore, will not explain the whole amount of visual imperfection which accompanies strabismus, but only so much of it as may be got rid of in addition to that which immediately re-

sulted from the operation. To illustrate my meaning—if the seeing power of the good eye be expressed by 10, and that of the squinting one, before the operation, by 4, let us assume the immediate result of the operation to be to increase its power to 8 ; then, if it subsequently become equal to the other, the difference between 8 and 10 will express the amount of imperfection that is due to disuse.

It appears to me that those who have advocated the hypothesis of disuse as a cause of impaired vision, have overlooked the fact of its improvement being *immediate* on the completion of the operation, probably from not having tested the sight just before and subsequent to its performance ; but observing, what indeed is notorious, that the vision, some days after the operation, is better than it was prior to its being undertaken, have attributed this improvement to the eye having been placed in such a position that the functions of the retina, that were previously suspended by the mal-position, could be resumed.

Dr. Franz affirms that there is merely a transposition of the naturally most acute point of sensation of the retina to another point internal to it and coincident with the axis of the distortion, and he has satisfied himself that this abnormal point of most acute sensation in a squinting eye, has nearly the same power of sensation as this point in its normal situation in the sound eye ; he explains the appa-

rent imperfection of vision thus—"The weakness of sight," he says, "which is observed when, on closing the sound eye, the affected one is brought, by an effort of the will, to bear upon an object, appears to me to be dependent, in a great measure, on the circumstance only that the image of the object which is seen while the eye remains in this unusual position, is projected on a point of the retina situated at some distance from the abnormal point of most acute sensation, viz., on a point less sensitive."

He also affirms that on rectifying the eye by operation, the abnormal point of most acute sensation gradually diminishes in sensibility; while that part of the retina which corresponds with the antero-posterior axis of the eye regains its power, so that after awhile the retina of the previously squinting eye corresponds with that of the sound one, and its vision becomes, in all respects, equally perfect.

The only case I have met with which bears directly on this question, is that of Emma Trip, before related. In this patient the point of most acute sensation of the retina coincided with the axis of the distorted eye, while the presumed normal point of most acute sensation was very deficient in sensitive power.

Now, on the above hypothesis, the rectification of the eye should have diminished the one and increased the other. Yet what was the result? Notwithstanding the eye preserved its normal posi-

tion, and images were consequently depicted on the same point of the retina as on the sound eye; while the point which coincided with the axis of the previous distortion would be comparatively unexcited; notwithstanding, also, that the sound eye was bound up for two hours daily, in order that more work might be thrown on the squinting eye—I say, notwithstanding all these circumstances, the assumed normal point of most acute sensation had gained nothing, nor had the abnormal point lost any of its former sensibility more than three months after the operation; but vision remained precisely at the point to which it had been raised by the operation; that is to say, immediately after its performance the improvement was manifest and decided, from an inability to read the largest type to a power of reading the pica. But there it remained, and three months effected no further improvement.

The theory of the transposition of the most acute point of the retina to another point, is based on the assumption that such a point really exists, and that it corresponds with the yellow spot of Sœmmering, which you know is situated in the antero-posterior axis of the eye.

Experiments which I have recently made throw some doubt on the correctness of this opinion, and lead me to believe that, in the healthy eye at least,

a large portion of the retina is possessed of the same power.

With reference to the hypothesis which attributes the impaired vision *to compression of the optic nerve* by the recti muscles, I have very little to say, except to express my dissent to this view.

It was supposed by the late Mr. James Adams, that certain cases of amaurosis were due to such compression, and he applied the term muscular amaurosis to these cases ; but having carefully read through his small treatise on the subject, together with the cases which he has published in confirmation of his views, I confess that it has failed to carry conviction to my mind ; and, without doubting the facts which he has brought forward, I am simply at issue with him on the explanation which he has given of them ; for it appears to me highly improbable that the contraction of the recti muscles should be capable of exercising any compression of the optic nerve, while their insertion is into so moveable an organ as the eyeball, which would immediately respond to such a contraction, and by so doing prevent any traction being made on the nerve.

With reference to this nerve or the retina being *affected by the same cause as that which produced the distortion*, I think it by no means improbable that many of those cases in which no improvement of sight results from division of the faulty muscle, are of this description.

Admitting, therefore, that in certain cases of strabismus, the seat of the impaired vision may be in the sentient parts of the organ of sight, or in the brain, I am of opinion that in the majority of cases *it resides in the dioptric parts of the eye*, which have undergone some change of form, or tension, by muscular action. It is only on this hypothesis that one can explain that curious phenomenon, the immediate improvement, and sometimes complete restoration of vision, which follows division of the faulty muscle in strabismus—a fact, by the by, which adds weight to the opinion of those who maintain that the defective vision is, in nearly every instance, the *consequence*, not the *cause*, of the strabismus.

Of the important part played by the muscles in vision, abundant evidence is afforded, not only by the phenomena which accompany strabismus, properly so called, but by those which are observed in all cases, as far as my experience at present extends, in which the balance of power of the orbital muscles is disturbed sufficiently to produce distortion of the eye. In all those instances, therefore, of paralysis of the muscles supplied by the third nerve, as well as in those in which the abducens is paralysed, of which I have given examples in a former Lecture, we meet with the same kind of defective sight ; nor has the mere direction of the eye, or the condition of the pupil, anything to do with it, inasmuch as it

occurs equally when the cornea, from paralysis or spasm, occupies any other position than inwards or outwards ; equally in paralysis of the external rectus when the pupil is unaffected, as in paralysis of the internal rectus when it is fully dilated.

And this impairment of sight goes hand in hand with the paralysis of the muscles ; it comes on with it, increases with it, and disappears with it, so that it is obviously not the result of disuse of the eye, and can only arise from the cause indicated.

It is true an objection might be urged that the paralytic condition of the muscles, and the defect of sight, do not stand in the relation to each other of cause and effect, but that both may be consequences of the same cause ; in fact, that the disease which has affected the third nerve, or the sixth, may have likewise implicated the optic. That this is sometimes the case there can be no doubt ; disease about the base of the brain, or tumours occupying this situation, we all know may interfere with the functions of several of the nerves at a time ; but then we always have symptoms by which the same may be recognised.

Now, in the majority of cases of paralysis of the motor oculi nerve, there is nothing present which would lead one to infer that the optic nerve was implicated ; none of the symptoms which characterise amaurosis, no *muscæ*, no insensibility to the stimulus

of light ; on the contrary, there is some degree of intolerance. In short, the impairment of vision which accompanies paralysis of the motor oculi, or of the abducens nerve, is of a different character from that which results from affections of the optic nerve or retina.

I think it, therefore, impossible to resist the force of such facts as these, which so clearly point to the muscles as the agents, both of the distortion and of the impaired vision. The mode in which they effect the latter, I imagine to be, by altering the form or tension of the eyeball, so that it is rendered either too much, or too little refractive, or may in some instances be made to refract irregularly.

The celebrated Dr. Young and the Astronomer Royal both suffered from irregular refraction, so that the rays which diverged vertically from an object, were not brought to a focus at the same distance as those which diverged horizontally from the same object, and thus impaired vision resulted.

That the refractive condition of the eye may be materially altered by the action of belladonna I presume most of you are aware. The eye is rendered highly presbyopic, in consequence, as I believe, of the ciliary muscle, by which the focal distance of the healthy eye is regulated, being paralysed by the action of the narcotic.

Now, the impaired vision which results from stra-

bismus is more nearly allied to presbyopia than to any other defect, as you will be convinced of, on comparing the subjective phenomena of strabismus with those which follow the application of belladonna to the eye, or from arming the latter with a deep concave lens.

I will read you a few notes of an experiment I performed on my own eye in confirmation of this position.

“ABSTRACT OF RESULTS OBTAINED BY THE APPLICATION OF BELLADONNA TO THE RIGHT EYE, AT HALF-PAST NINE P.M., SEPTEMBER 14, 1840.

“ In reading or writing the unaffected eye only is used, and on closing it not a letter can be distinguished by the other, although the lines of print or writing with their interspaces can be discerned with very undefined outlines. With the greatest difficulty, the words

‘ PRINTING AND PUBLISHING ’
can be made out in the title page of the ‘ Author’s Assistant,’ and this is rather guessed at than distinguished.

“ The only difference observable on moving a book to or from me is, that the lines with their interspaces become more distinct as the book is moved away, but, in proportion as these become more defined, so the type becomes smaller and smaller, and

appears at a much greater distance than its real situation. On approximating the book, the contrary results take place, and the definition becomes so very indistinct that the lines and their interspaces appear almost of the same hue. But though they appear thus, when the good eye is closed, no distinct second image is formed when both are open, only there is an indistinct cloudiness before the narcotised eye, which interferes with the comfortable vision of the other.

“ The power of measuring distances is also impaired ; thus, when I commence writing, I generally do so above the paper, from not clearly seeing when the point of the pen comes into contact with the paper. This defect is not remedied by closing the narcotised eye, and therefore is independent of it, and to be attributable either to the measuring distance being generally performed with the other eye, or, what is more probable, from this faculty depending on the simultaneous action of both eyes.

“ On placing a convex lens before the narcotised eye, vision becomes distinct and perfect ; on adapting it to the sound eye the vision of this is more distinct than without it, as none of the floating haziness before the other eye is now observed.

“ This high state of presbyopia came on gradually, a few minutes after the application of the belladonna was made ; the objects first appearing smaller, and the focal distance being greater ; thus, in reading, the

words on the left half of the line were seen of their natural size, with the left eye, and those on the right much diminished with the right or narcotised eye.

“The latter soon ceased to distinguish the words, and then the left only was employed in vision, while the right impeded it, with the indistinct haziness, so that vision was clearer when this eye was closed.”*

Now, if such results as these can be produced by paralysing the ciliary muscle, it is surely not unreasonable to infer that a loss or increase of power of one of the recti muscles, by altering the form or tension of the eyeball, may interfere with its adjustment for distinct vision, and so occasion the phenomena we are endeavouring to explain.

I have dwelt somewhat longer, gentlemen, on this part of my subject than was my original intention, because it suggests some questions of importance relative to the pathology of impaired vision generally ; thus, if it be admitted that the ciliary and recti muscles are capable of affecting vision in the manner I have described, it seems impossible to resist the conclusion, that the obliqui may also act in a similar manner, and some of the many cases of impaired

* This is a mere abstract of those results of the experiment which bear more particularly on the subject of strabismus. Some important facts were elicited in reference to the physiology of vision, which I have not introduced ; but they may hereafter form the subject of a separate contribution.

vision which daily fall under observation, and which are now attributed to a nervous source, a more correct pathology may demonstrate to have their origin in the muscles, while improved means of diagnosis may enable us to determine, not only the symptoms by which the nervous and muscular forms of impaired vision may be distinguished, but those which are proper to the abnormal or defective action of each of the groups of muscles connected with the eyeball.

These opinions derive support from a recollection of the condition of the pathology of the ear only a few years back, when, as many of my hearers are aware, all cases of deafness that were unaccompanied by any outward or visible sign of disease, were supposed to be of nervous origin : though now we know that many of these are altogether independent of such a source.

It must not be forgotten, however, that instances, every now and then, are met with, which seem to invalidate the theory of muscular action as a cause of impaired vision. I allude particularly to those cases of strabismus in which the sight is unaffected.

Such cases can only be explained on the hypothesis I have advanced in a former Lecture, namely, that strabismus may sometimes arise, not from a loss of balance of power of the orbital muscles, but of the consensual or co-ordinating power, by which the two eyes of a healthy individual move together harmoniously.

LECTURE VI.

ON THE TREATMENT OF STRABISMUS.

GENTLEMEN,

IN my first Lecture I made you acquainted with the circumstances which induced me to call your attention to the subject of strabismus; and I stated that one of my principal objects was to point out to you the description of cases that would be benefited by operation, together with the proper mode of performing it: the present Lecture, therefore, will be devoted to the consideration of these objects. It will be more convenient, however, if I adopt the converse plan of pointing out to you the cases on which you should avoid operating.

In the first place, then, all those cases should be rejected *in which the distortion enables the individual to see better than he would do were the eye undistorted*, as for example, when dense central opacities exist on both corneæ, or when the sight of the straight eye being entirely lost, and opacities exist-

ing on the cornea of the other, the distortion of the latter allows more light to fall on the retina, than if it had its normal direction. Secondly, you should not operate *when the distorted eye is either completely amaurotic, or affected with cataract*; for the functions of the retina being destroyed or suspended, its guiding or controlling power is wanting; and thus the eye is given up to the action of the muscle whose antagonist has been divided, and eversion is apt to ensue. In this manner may be explained the eversion which followed an operation on a female, fifty-four years of age, who was affected with cataract of the squinting eye, and whose case has been reported by Mr. Charles Guthrie. The removal of the cataract of this patient, previous to the operation she underwent for strabismus, might possibly have prevented such a catastrophe. Thirdly, the operation should not be undertaken *when the distortion arises from complete paralysis of either the external or internal rectus*, as in the cases of Palmer and Brooks, already alluded to. Division of the unparalysed muscle, in either of these cases, would not rectify the squint, while, at the same time, under proper treatment, it is not unfrequently recovered from without operation.

There is an exception which may be made to this; as when the paralysis has been of long duration, and recovery from it is not likely to ensue. Under such circumstances the contracted and unparalysed muscle

may be divided, and the eye removed from its unnatural position by artificial means, which I shall shortly allude to. Of course such a case would not be so perfect, as one in which the external rectus was unparalysed ; but still an eye in the centre of the orbit, though capable only of moving in an upward and downward direction, is a less defect than one that is inverted.

I called your attention in a previous Lecture to the frequency with which the eye affected with strabismus differs from the sound one, not only as regards its visual power, but its apparent bulk. Now if the latter be on the side of excess it will offer a serious impediment to the operation, and as this is a point which has not been sufficiently insisted upon by surgeons, I wish particularly to impress upon you the inexpediency generally of meddling with these cases.

The reason for refraining from interference is, that the tendency of the operation is to increase the prominence of the eye, so that if it were previously the fuller one of the two, the operation will increase this fulness, and the patient will but exchange one deformity for another. Under these circumstances it becomes a question, how far the appearance may be improved by the exchange. When the difference in the prominence of the two eyes before operation is but slight, I should recommend its careful performance in the manner to be presently pointed out, in-

asmuch as an eye that is but slightly fuller than the other, if parallel, is a less defect than a squinting one. But *when the apparent size of the squinting eye much exceeds that of its fellow*, by all means avoid the operation, a greatly protruding eye being more ungainly than an inverted one.

The tendency of the operation to increase the prominence of the eye, is a favourable circumstance when the squinting organ is apparently smaller than the sound one, as it not only restores the parallelism of the two, but renders them equally prominent, and therefore symmetrical. Hence squinters thus affected form by far the most favourable subjects for operation.

This effect of the operation is owing to the antagonism of the recti and obliqui muscles being destroyed ; the latter, being thus rendered relatively more powerful, pull the eye somewhat forwards ; but this is a subject which I have explained so fully in my first Lecture on the anatomy of the eyeball, that no further explanation is now required.

If now you were to ask me what kind of cases may be beneficially treated by operation, I reply, all those which are not included in the exceptional ones just pointed out to you. I will now proceed to describe the operation.

The instruments which are usually employed for this purpose are, a speculum for the eyelids, a pair of

ordinary dissecting forceps, a pair of probe-pointed scissors, and a blunt hook. Some surgeons make use of a double tenaculum to draw the eye from its unnatural position, and keep it steadily fixed till the blunt hook has been introduced beneath the muscle ; while others substitute a grooved director, and a small sharp pointed bistoury for the blunt hook and the scissors. Whether the knife or the scissors are employed in the division of the muscle is a matter of little moment, the latter are perhaps preferable, inasmuch as the tissues to be cut through are so delicate and yielding in their nature, that they offer scarcely sufficient resistance to the knife which must exercise some degree of traction on them, and thus raise them unnecessarily from the sclerotic. The double tenaculum I prefer to the forceps (and I have never yet seen any evil result from its employment in the hands of those who understand its use), because it has more power over the globe of the eye, in drawing it from its mal-position into one eligible for the operation, and keeping it steady till the section of the conjunctiva is completed ; whereas, the forceps by laying hold only of the conjunctiva, and not of the sclerotic, disturbs the relations of these two membranes to each other, and is less effective in drawing the eye from its mal-position.

Having selected your case, and bound up the sound eye, a proceeding which much facilitates the opera-

tion, the spring speculum of Mr. Coxeter should be attached to the lower eyelid, whilst an assistant, standing behind the patient, with the finger of one hand, or a speculum, raises the upper lid, he then, with the other hand, draws the eye from its unnatural position by means of the double tenaculum inserted into the sclerotic, one or two lines internal to the margin of the cornea. The eye being thus fixed, the operator, with a pair of scissors, makes an incision three or four lines internal to the cornea, or about midway between it and the caruncula lachrymalis, commencing at a point a little below a line horizontal with the lower border of the cornea.

This section must be made to include, not only the conjunctiva, but the ocular fascia, extending quite down to the sclerotic coat, the lower blade of the scissors must then be pushed from below upwards, in a vertical direction, care being taken to keep it in close contact with the sclerotic, while all the structures intervening between the two blades, as high up as a line corresponding with the upper margin of the cornea, are cut through with a few sweeps of the instrument.

Another plan is to insert the blunt hook into the aperture first made, and direct its point upwards, in a similar manner as was done with the lower blade of the scissors. The double tenaculum, which is held by the assistant, may now be dispensed with, as the

operator, by means of the blunt hook passed beneath the rectus, as just described, has the eye completely at his command. The scissors may now be used in the manner already described.

Where the knife is employed instead of the scissors, the operation must be commenced with a small incision made by the latter, as in the former method. Through this aperture a grooved director is passed beneath the muscle till its point is on a level with the highest part of the cornea. A sharp-pointed bistoury, guided by the director, is now made to cut its way outwards, dividing in its passage all the intervening structures.

Whichever of these methods of operating be adopted, it is very essential that the cut edges of the conjunctiva should be brought into apposition with each other on the completion of the section, so as to insure, if possible, union by the first intention. If this precaution be neglected, the wound heals by granulation, and a fungus-looking mass makes its appearance, which generally requires removing by the scissors. But this is not all, for the conjunctiva becomes retracted at the inner canthus, the plica semilunaris and caruncula disappear, and an unpleasant vacuity occupies their place, which destroys the symmetry of the two eyes, and mars the effect of the operation.

These results so frequently follow the operation just described, and as ordinarily performed, that I

have lately adopted the sub-conjunctival section of the muscle, which possesses the further advantage of counteracting, to a certain extent, the tendency to protrusion. Hence it is peculiarly adapted for those cases in which the squinting eye is somewhat fuller than the other.

This mode of dividing the faulty muscle was, I believe, first recommended by M. Guerin, in France, and it has been advocated and practised by my colleague, Mr. Brooke, in this country.

The first steps in the performance of this operation are similar to those I have just described. Into the aperture made by the scissors, a bistouri caché, as it is called, such as this I hold in my hand, must be inserted, and passed vertically upwards. By means of a spring the knife is now raised from its sheath, with its sharp edge directed towards the conjunctiva, and its back towards the sclerotic. A slight sawing movement is given to it, by which the muscle is divided, the conjunctiva, however, remaining intact, except at the point where the instrument was first made to enter, and through which it must now be withdrawn.

This operation, though not quite so easy of performance as the former one, possesses these advantages over it.

In the first place, the small puncture made by the scissors is entirely covered by the lower eyelid, so

that not only is there no breach of continuity visible in the conjunctiva, but all air is excluded from the wound, and thus the accession of inflammation is prevented.

Secondly, the relations of the conjunctiva to the eyeball and the eyelids, being undisturbed by the operation, the symmetry of the two eyes is preserved, and the plica semilunaris and caruncle maintain their normal position.

Lastly, it is followed by less protrusion of the eye than results from the ordinary method of dividing the muscle.

Rather more ecchymosis takes place after this operation than the ordinary one, but the blood is quickly absorbed, and in no way interferes with the ultimate success.

A surgeon who undertakes the cure of strabismus by operation, must be prepared to meet with occasional failures, notwithstanding the cases selected are of a proper character, and do not belong to any of those exceptional ones which I have previously enumerated; thus *the eye may remain inverted* after division of its adductor muscle; or *the squint, though removed at the time, may return* some days or weeks afterwards; or again, *the previously straight eye may become affected*.

The failure of the eye to right itself immediately may depend either on imperfect division of the in-

ternal rectus muscle, or on adhesions between it and the sclerotic, through the medium of the ocular fascia ; or lastly, on a weakened condition of the external rectus muscle.

I have very little doubt that many of the failures which have been recorded, were due to portions of the faulty muscle being left undivided ; and I am the more convinced of this fact, since my attention has been directed to the insertions of the recti muscles, and I have become aware of the breadth of the tendon of the internal rectus, not unfrequently exceeding half an inch. Now to any one ignorant of this fact, an incomplete division of the muscle would be very likely to occur. M. Velpeau affirms that he has seen the internal rectus inserted into the posterior part of the eyeball, and M. Philips has met with cases in which this muscle had three insertions (*inseré par trois languettes*), of which the anterior only was divided in the operation, while the other two escaped observation. My own experience has not furnished me with any such anatomical peculiarities, either in the dead or the living, nor have such been recorded by any English anatomists or surgeons. I am of opinion, therefore, that M. Philips must have mistaken the margins of the tendon of this muscle, which we have seen are inserted into the sclerotic further from the cornea than the central portion for separate insertions, which indeed they would some-

what resemble after the intervening portion of the tendon had been divided.

With reference to adhesions of the ocular fascia and muscle to the eyeball, of which such numerous instances have been given by Mr. Duffin, I have only to remark, that when such adhesions constitute the obstacle to the rectification of the eye, they must be divided and the eyeball liberated. If the squint should continue in spite of the complete division of the internal rectus muscle, and the separation of any adhesions between it and the sclerotic, the inversion is probably owing to a weakened condition of the abductor muscle, and nothing more is necessary than to bind up the sound eye for a few days, the weakened muscle will thus be called into action, and will shortly acquire power sufficient to prevent a recurrence of the inversion after the sound eye is unbound. I must particularly caution you against the division of more than one muscle in the same eye, as formerly was so commonly practised ; this proceeding is certain to be followed by great protrusion, and not unfrequently by a squint in an opposite direction ; results which have contributed to bring a very simple and effective operation into unmerited obloquy. Should you therefore meet with one of these cases in which the squint persists after complete division of its abductor muscle, and the separation of any adhesions between it and the sclerotic, you must not be dis-

couraged, nor must you attempt anything further by way of operation at that time. Many of these cases are not so much failures as examples of deferred success, in which the eye eventually rights itself, though occasionally not till some days afterwards.

On the contrary, should no alteration have taken place at the end of eight or ten days, the inner muscle of the opposite eye should be cautiously divided. This is a great improvement upon the former method of dividing either part or whole of the superior and inferior recti muscles of the same eye, and some of the most successful examples of the cure of strabismus have resulted from this double operation being undertaken. Some few cases, I believe, have been recorded in which this proceeding has been followed by eversion of one eye ; but as far as I have been witness to the results in my own practice, I have not yet met with such an untoward event : I therefore feel some confidence in recommending this plan, where not contra-indicated by any special circumstance connected with the case. M. Dieffenbach, Philips, and Wylde have recommended another plan to be adopted in the kind of cases we are now speaking of ; this consists in fixing the eye in the centre of the orbit by means of a fine ligature passed through the sclerotic extremity of the divided muscle, the other end of which is fixed to the temple by means of a piece of plaster : the ligature becomes detached by ulceration between

the fourth and seventh days ; at the end of which time the eye has lost its tendency to inversion, and the cure is completed. I have not seen this method put into practice, but should feel disposed to make trial of it in cases in which division of the internal rectus of the opposite eye is contra-indicated, or in which the strabismus has been converted by means of the operation into one in an opposite direction.

It sometimes happens that the operation, though apparently successful at the time of its performance, is, after a longer or shorter period, followed by a relapse, and the patient squints nearly as badly as he did before. This may be owing to several causes. For instance, it may sometimes arise from the contraction which follows the cicatrization of the wound made by the operation, as suggested some years ago by my friend and colleague, Mr. Charles Brooke ; or again, the divided muscle may become re-attached to the globe too near its original insertion ; or, lastly, it may be the result of an hypertrophied condition of the inner rectus of the straight eye.

Instances of the return of strabismus from a re-attachment of the muscle to the eyeball, have frequently been recorded. Thus, Mr. Lucas asserts that he has several times been obliged to perform a second operation, and that on these occasions he was able distinctly to see both the original and the new insertions of the muscle. It has also been corroborated by

a dissection made by M. Lenoir, and quoted by M. Berard, in his article on the subject of Strabismus, in the "Dictionnaire de Medecine." Again, the muscle may be attached to the sclerotic mediatly through the intervention of a band of condensed cellular tissue, or ocular fascia, as in the following case, related by Mr. Prescott Hewett. The patient was affected with divergent strabismus, for which he underwent the operation of division of the abductor muscle of the squinting eye. The success at the time appeared to be complete, but rather more inflammation followed than is usually observed in these cases, and after its subsidence, the defect, though diminished, was not removed. Exactly one month after the operation he died of pneumonia ; and on examination of the orbit, the external rectus was found to be completely divided just at the point where it was beginning to be tendinous : it had retracted to about three-fourths of an inch, but was connected with the globe by a strong band of cellular tissue, about three lines in width and six in length, and was attached to the ball of the eye about two lines behind the original insertion of the muscle. Mr. Hewett observes,—
" There can be no doubt that this band consisted of the loose cellular membrane which naturally connects the muscle with the globe, stretched into this elongated form by the retraction of the muscle, and afterwards condensed by inflammation."

Examples of an hypertrophied condition of the inner rectus of the sound eye leading to a re-inversion of the previously squinting one, after its obliquity had been completely removed by operation, have been recorded by Mr. Radcliffe Hall and others. These cases were treated by dividing the hypertrophied muscle of the straight eye, and, according to the operators, with success. I confess, Gentlemen, my inability to point out to you the mode by which such cases of hypertrophy may be diagnosed before operation, it not having fallen to my lot to meet with any ; but were I to meet with them, I should certainly think twice before I divided the adductor muscle of the straight eye.

There is one result of the operation that I have yet to speak of, namely, the transference of the squint to the eye which was previously straight. In a former Lecture I pointed out to you that this transference of the squint from one eye to the other was in some cases only apparent, and resulted from a participation of the supposed straight eye in the obliquity of its fellow, such cases being examples of double convergent strabismus in which the two eyes are unequally affected. Every now and then, however, it happens that the eye which was previously quite unaffected becomes somewhat inverted after its fellow has been rectified by operation. Should such a result ensue, it would be necessary to treat it in the same

manner as if it had been originally the faulty eye, and divide its internal rectus accordingly.

I have now enumerated all the circumstances by which the success of the operation for the removal of strabismus is liable to be interfered with, and regard being had to these circumstances, as well as to those which would contra-indicate its performance, there is no operation in the whole range of surgery that is attended with more success or so little risk.

I have purposely abstained from calling your attention to the various contrivances which have been invented for the cure of strabismus without operation, I will merely observe, that I am at present engaged in the prosecution of some experiments having this object in view, and the results of which I will lay before you on a future occasion.

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